THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 30. Thursday, July 24, 1924. No. 414.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
The International Aspect of Foundry Technical Societies	65
Discussion on Foundry Trades' Exhibition Papers	66
Foundry Query	66
British Cast Iron Research Association Laboratories	66
Information Bureau and Special Libraries	66
American Foundrymen's Association	66
Permanent Moulds for Brake Blocks	67
The Foundries of Messrs. Glenfield & Kennedy	68
Institute of British Foundrymen	70
American Government Specify Pig-iron by Rule	70
Objects of a Cost System	71
The Development of Alloy Steels	72
Efficient Methods of Preparing Foundry Facings	76
American Specifications for Cast-iron Pipes	77
Papers to be read at the A.F.A. Convention	77
Device for Cleaning Castings	77
The Welding of Cast Iron from a Metallurgical Point of View	78
The Evolution of the Pig	80
Shock absorbing Hammers	80
Steel Rail Practice in America	81
Symposium on Diesel Engine Castings	81
A.F.A. Prize for Ideas	81
The Rapid Production of Malleable Iron	82
A Self-Contained Magnet Scrap-Handling Crane	83
Trade Talk	84
Company News	84
Obituary	84
Iron and Steel Markets	86

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1924-25, R. O. Patterson, Blaydon-on-Tyne.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.

Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.

Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.

Sheffield: R. Village, Albion Foundry, Whittington Moor, near Chesterfield.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.

Newcastle-on-Tyne: Colin Gresty, 93, Queen's Road, Monkseaton, Northumberland.

East Midlands: H. Bunting, 17, Marcus Street, Derby.

Coventry: J. M. Meston, 37, Melville Road.

West Riding of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Drualyn, Bishops Road, Whitechurch, Glam.

Welsh Engineers' and Founders' Association.

Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

The International Aspect of Foundry Technical Societies.

There are between 20 and 30 associations spread over the world which are wholly devoted to foundry matters which make provision for the reading and discussing of technical matters, The oldest, largest, and most important is the American Foundrymen's Association. This Association has only one grade of membership, which can be either a personal one or that of firm, when its representative is specified. It has for its field a continent. Much revenue is derived from the organising of foundry exhibitions, which are held in different centres each year. It has no branches, and meets but once a year, when a large number of technical papers are read. It carries out a vast amount of useful technical research through sub-committees, and has representation on many national committees where matters of foundry interests are included in the scope of their considerations. In addition to the national American association, there are a number of district associations in towns such as Pittsburg, Quad City. Foundry supply and equipment firms are included in the membership, but any attempt to use these associations for pushing business is discouraged.

In addition to purely foundry technical associations, America has several co-operative foundry research associations, and the one catering for the malleable trade can truthfully be said to have revolutionised and improved American practice out of all recognition. Another devotes its energies to electric steel foundry work, and it also is doing much good work for its supporters.

The Association Technique de Fonderie is the French national society. It has been re-established during the last few years, and is making wonderful progress. It has several grades of membership, which places it within reach of all interested in foundry work. Like the American association, it organises exhibitions, welcomes equipment and supply people, devotes much time to the education of foundry apprentices, the testing of cast iron, etc. There are no other known societies in France, and up to now no local branches have been formed. In addition to the annual conference, a regular session is held in Paris, supplemented by an odd lecture here and there. An outstanding feature is the foreign membership list, and the association shows promise of being the centre of foundry thought for Switzerland, Italy, Spain and Portugal.

Recently a malleable iron research association has been formed in France on co-operative basis. France, of course, has its employers' federations, but is peculiar in that it is the only country to run a foundry mutual benefit association, which has a good deal of support from the foundry owners.

The German Foundrymen's Association is conducted on very similar lines to the American society. Perhaps its outstanding feature is the excellent research work done through its sub-committees.

The Association Technique de Liége has recently changed its name to "de Belgique," so as to give it a national character. It is run on similar lines to the French organisation. It has done most excellent work in the standardisation of foundry costing.

The Swedish, Dutch, Norwegian and Italian Associations are primarily employers' federations which occasionally have papers of a technical character presented at their meetings.

The Institute of British Foundrymen has evolved its own organisation, taking as its model the old-established engineering societies, but it

has modified the procedure by having only one annual gathering instead of two. Further it originated the system of branches, a lead which has been thought worthy of imitation by several of the most important of British technical societies. The British association admits no foundry supply or equipment firms or their repre- [redacted] as such. It is precluded from [redacted] Charter. Its outstanding feature is its contributions to science by the presentation of numerous metallurgical papers capable of easy practical interpretation. Its poorest feature is its comparatively poor colonial and foreign membership list.

Discussion on Foundry Trades' Exhibition Papers.

POROSITY IN CAST IRON.

By ARTHUR MARKS, F.I.C.

In the course of a brief discussion, MR. R. BUCHANAN said the Paper dealt with their perennial troubles, and it was valuable to hear the views of a scientific foundryman. For himself, when he saw a bright cavity, sometimes almost silvery, he concluded it was an air cavity. When the cavity was dark, almost black, he considered it was a draw. He would like to learn Mr. Marks' method of deciding the point. To his mind the main cure for blowholes at the top of castings or elsewhere was to cast hot, because the power of the metal to hold gases in solution was very much greater when the metal was hot than when it was cold. There was a tendency to-day in the foundry world for the best type of castings to have a lower graphite content not only in the pig-iron but in the castings themselves. He thought that was right, but the control of the carbon, as Mr. Marks had indicated, was largely in the hands of the cupola man himself or the foreman who controlled him. There was little use in perhaps paying extra money for low-carbon pig-irons if the melting conditions in the cupola were going to give back the amount of carbon whose absence they had paid a price for. It was wasted money unless they controlled the carbon in the cupola, and that was possible to a certain extent. Upon the quantity of total carbon in any casting largely depended whether their castings were going to be clean or not.

Mr. Marks was cordially thanked for his address, and, replying to some of the points raised, said it was only by examination of a casting in the light of every factor that they could definitely decide whether a cavity was due to gas or to a draw. There were many cases where the colouration and other surrounding features would point to the trouble being caused by gas. On the other hand, where there was no colouration, it was very difficult to decide whether a cavity was due to gas or to a draw. By the use of a hand microscope with a good magnification, however, the character of the crystallisation of the cavity could be examined, and after some experience that should enable one to decide the question. A large percentage of gas troubles in castings were undoubtedly due to defective washes—either an excessive amount of clay admixture or other binding agents which were often sold as "cure-alls." Every practical foundryman would be in agreement with Mr. Buchanan when he said "cast hot." Casting hot was the only way in which they could get over gas porosity in general work. He also agreed with Mr. Buchanan as to the folly of paying extra for low carbon irons. One did not need a low-carbon pig-iron to-day in any foundry.

Foundry Query.

Moulding Rain-water Pipes.

I should be glad if you could obtain for me detailed information as to the methods used for the moulding of rain-water spouts and connections, or put me in touch with anyone who would be kind enough to supply me with sketches of suitable boxes, core irons, etc.—FOUNDRY MANAGER.

British Cast Iron Research Association Laboratories.

A further stage in the development of the Cast Iron Research Association was reached a few days ago when the Association formally took possession of its own laboratories. These are situated in Guidford Street, Birmingham, and are equipped for the conduct of chemical analyses and general metallurgical and heat treatment work. The capacity of the Association to deal with its work will be greatly increased, but it is not intended to abandon the policy of having investigations conducted in prominent University laboratories and in the works of members.

It is anticipated that the Association, which commenced a new financial year on July 1, will incur an expenditure during the year of between £6,000 and £7,000. The research programme includes important investigations on erosion- and corrosion-resisting cast irons; moulding sands; graphitisation; heat-resisting cast iron; the production of malleable cast iron; cupola practice; cast irons for electrical and magnetic purposes; measurement of melting and pouring temperatures; the fundamental properties of cast iron; standardisation of test bars, materials and methods; facing sands and blackings, and cast iron to resist abrasive wear, and jointly with the British Motor and Allied Manufacturers' Research Association, automobile cylinders and pistons.

Recent new members include the Brightside Foundry & Engineering Company, Limited, Sheffield; Powell Duffryn Steam Coal Company, Limited, Glamorgan; Boving Engineering Works, Limited, Stoke-on-Trent; J. Blakeborough & Sons, Limited, Brighouse, Yorks; J. W. Jackman & Company, Limited, Manchester, and Younger & Callon, Dunston-on-Tyne.

Information Bureau and Special Libraries.

A conference will be held at High Leigh, Hoddesdon, Herts., during the week-end, September 5 to September 8, to which are invited all men and women who need to utilise information systematically, or who are interested in the conduct or operation of information bureaux, intelligence services and special libraries.

The programme will include papers and discussions on the functions, future developments, and the methods and equipment of intelligence bureaux, and on their relations with other institutions, including national and public libraries. It is hoped to obtain representatives of such varied fields of activity as Government and municipal departments, technical and research institutions, industrial concerns, financial houses, insurance offices, newspapers, and civic and social organisations, all of which have a common interest in the collection, treatment and dissemination of facts and information relevant to their particular activities.

Further information may be obtained from Mr. A. F. Ridley, Athenæum Chambers, 71, Temple Row, Birmingham.

American Foundrymen's Association

The Nominating Committee of the American Foundrymen's Association for the year 1924, consisting of Past Presidents C. S. Koch (chairman), W. R. Bean and C. R. Messinger, Messrs. A. H. Jameson, Jesse L. Jones, Warren G. Jones and S. W. Utley, elected by mail ballot of the members, have unanimously nominated the following as officers and directors of the Association:—Mr. L. W. Olson, Works Manager, Ohio Brass Company, Mansfield, Ohio, as president; Mr. A. B. Root, Jun., Mechanical Engineer, Hunt-Spiller Manufacturing Corporation, Boston, Mass., as vice-president: Messrs. V. E. Minich, G. H. Clamer, John E. Galvin, J. E. Hageboeck, R. A. Nourse and Wm. J. Nugent as directors.

RHODES CHAINS, LIMITED, have removed their registered office to 178, Charing Cross Road, London, W.C.2. The company's factory is at 117-119, Stoke Newington Road, London, N.16.

Permanent Moulds for Brake-Blocks.

By J. E. P.

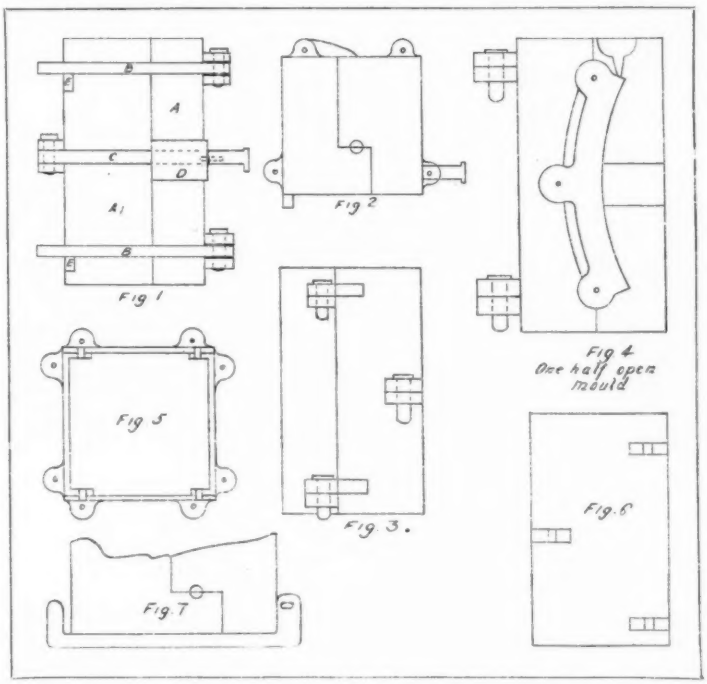
Brake-blocks are suitable articles to cast in permanent moulds, in consequence of their design, thickness, and absence of any difficult objectionable protrusions.

Of course there are difficulties to be overcome, and perhaps the greatest of all is the chilling effect of the cast-iron mould upon the castings; this can be minimised to a very great extent by the use of the right metal, both for the mould and the casting.

A good mixture of metal for the mould is hematite—twice melted—with 20 per cent. of steel added.

The metal for the castings should be that which takes the least chill; a No. 3 hematite has shown as little as 1-32 in. chill.

The dressing of the moulds, chills, and denseners has always been a debatable question, as the following list of dressings shows:—Oil and plumbago; watered carbon blacking (only applied when the mould is hot); resin wash; flour wash; core gum wash; Russian tallow and plumbago, and tar.



All these have been tried, and even now have their ready advocates.

In dressing the mould for a reversible brake-block—for the first cast—oil and plumbago was used, very thinly applied, after the mould was warmed up, but as time went on and the castings continued to turn out satisfactory, the dressing of the mould was not repeated.

Upon investigation it was found that some of the smoke from the oil cores (which were not quite dry) was being deposited upon the surface of the mould, thus dressing the mould.

Although not much smoke came off the cores at the time of pouring, yet when the castings were taken out, the small pieces of cores left in the prints at each side of the moulds gave off dense fumes which varied with the amount of oil in the cores after partial drying.

The smoke so given off formed a carbon deposit on the surface of the mould—which seemed to have an affinity for it—and gave a beautiful blue skin to the castings, such as a highly finished loam mould will give.

Even after the day's cast, there remained upon the surface of the mould a peculiar greasy deposit which could not be readily removed. So that one might assume these moulds were self-dressing.

The dressing of permanent moulds is a very important factor, and one which, when rightly considered, will perhaps have a marked influence upon the depth of chill on the castings.

In the case mould which has no cores, the sooty deposit could easily be obtained by using a lamp, or burning a piece of oily rag and letting the smoke impinge upon the surface of the mould. Crucible steel ingot moulds are dressed by burning creosote oil beneath them.

The temperature of the metal at the time of pouring should be very carefully studied until the best results are obtained.

Certainly, metal too hot must be cooled down, as hot metal would very soon burn the mould to such an extent as to render it useless. Metal too cold will give a badly marked casting.

The rate of pouring is also to be considered. Too slow pouring will result in the casting being cold-shut, so that if the metal is the right temperature the pouring should be on the fast side.

Type of Mould Used.

Fig. 1 shows the front view of the mould closed. The hinges which carry the clamps need not be a close fit, in order to enable the clamps to bite on the mould and not the pins (Fig. 7).

The small blocks E, Fig. 1, are to take the thrust off the clamps, when the wedges are driven home. C, Fig. 1 is a hinged bar to carry the sliding block D. This arrangement allows the blocks to move with two actions when opening the mould. Were this block cast on the opening half of the mould, A1 Fig. 1 it would prevent the opening of the mould.

C, Fig. 1, is the mild steel bar which carries the block D and works in the slot of A1, then through the sliding block D; this bar C has a hole in it to take a cotter pin for fastening the block D in its correct position.

The collar at the end of the bar C is to prevent the block D from sliding right off, and enables the mould to be closed more readily.

Fig. 2 is the top view of the mould showing the hinges—which must be a close fit—the joint line and the runner.

Fig. 3 is the back view of the mould showing hinges, lugs and pins. These pins are longer than the lugs, so that they may engage in the lugs of the stand, Figs. 5 and 6.

Four moulds can be fitted upon this stand quite easily, and all four can be in operation at one time.

This stand is cast in four sections and bolted together; a very simple arrangement, yet in the fullest degree effective, easy to manipulate and portable.

Fig. 4 shows the half mould open, with runner and the opening for the block D, Fig. 1.

The castings must be taken out of the mould as soon as possible, and put into a soaking pit, to reduce the chilling effect the cold air would have upon them.

XUM

The Foundries of Messrs. Glenfield & Kennedy.

(From a Correspondent.)

The light and heavy foundries of Messrs. Glenfield & Kennedy, Limited, the well-known engineers and ironfounders, of Kilmarnock, are undoubtedly, so far as design, equipment, organisation and quality of the castings produced are concerned, amongst the finest in Great Britain. These foundries can produce about 17,000 tons of finished castings per annum, with single castings up to 50 tons, quite apart from the general alloy, gunmetal and brass foundries, the latter of which alone absorbs about 20 tons per week.

FIG. 1.—MAIN BAY OF THE FOUNDRY. MESSRS. GLENFIELD & KENNEDY, LIMITED.

FIG. 2.—GENERAL VIEW OF THE LIGHT CASTINGS FOUNDRY. MESSRS. GLENFIELD & KENNEDY, LIMITED.

Before describing the general equipment, it may be stated that the firm undertake their casting operations on the most modern scientific principles, having a chemical laboratory with a staff of qualified metallurgical and analytical chemists, who work in co-operation with the foundry manager, carrying out regular daily analyses both of the raw material and the finished castings. Test pieces for both tensile and transverse tests are also taken daily, and certainly there are very few firms in the world that can surpass the methods they adopt in this direction.

Raw Materials.

A very large proportion of the metal used is special Scotch pig-iron with a low phosphorus

content, which, as is well known, is particularly suitable for the production of sound hydraulic castings, and the firm also manufacture a special toughened cast iron metal generally known as "semi-steel" cast iron, which is of the very highest quality.

Further, it may be stated that not only are the foundries fitted on the very latest lines with general handling and crane equipment, but they have "all-glass" roofs so as to improve the conditions of working, whilst at night lighting is by means of electric arc lamps. Also on winter mornings the whole of the buildings are warmed with hot air by means of the "Stanlock" unit system, which adds considerably to the comfort of the men, and at the same time the most modern methods of ventilation are installed. It is not necessary to point out that most foundries are being operated under extremely bad conditions in these respects, which largely accounts for the unpopularity of the foundry in many large works.

The complete foundry department at Kilmarnock is divided into two parts, for dealing with heavy and light castings respectively. The heavy foundry building has an area of 4,211 sq. yds., being divided into three bays, each of which is 250 ft. long, the main bay being 65 ft. wide with a height to the overhead crane rails of 40 ft. This bay is equipped in the first place with two 60-ton travelling cranes, and there is an ample assortment of hydraulic side cranes varying from 5 to 9 tons, these being installed in such a manner as to enable the moulding operations to be carried out with minimum labour expenditure. Further, there are provided in the various bays jolt-ramming machines capable of handling moulds for castings from 10 cwt. to 6 tons, and there are ample facilities for extensive loam moulding. Other equipment includes a casting pit 30 ft. deep, which allows the production of hydraulic rams up to no less than 40 ft. in length in one piece.

FIG. 3.—A CORNER OF THE LIGHT CASTINGS FOUNDRY. MESSRS. GLENFIELD & KENNEDY, LIMITED.

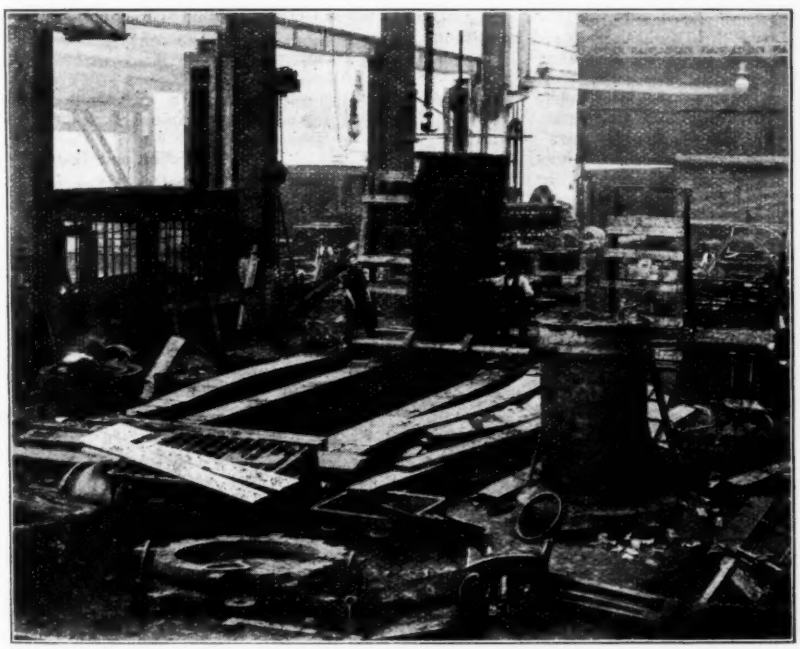


FIG. 4.—CASTING PIT, 30 FT. DEEP, IN THE HEAVY FOUNDRY. MESSRS. GLENFIELD & KENNEDY, LIMITED.

Messrs. Glenfield & Kennedy have, of course, been known all over the world for more than half a century past as hydraulic engineers, and in connection with this work the production of heavy hydraulic rams and cylinders necessitates very large castings. They have found it necessary to cast these vertically in dry-sand moulds, allowing

a large feeding head, and thus ensuring sound castings free from porosity and other defects.

The light foundry has an area of 4,740 sq. yds., being divided into four bays 250 ft. long. The main bay is 43 ft. wide, and has a total height of 44 ft., the other bays being 28 ft. high. As before, a full equipment of cranes is provided, consisting in this case of a 15-ton overhead electric travelling crane and hydraulic wall cranes varying from 1 to 5 tons capacity. In this section of the foundries the work is almost entirely confined to machine moulding. There are also jolt rammers varying in capacity from 10 cwt. to 4 tons, together with a complete installation of moulding machines, including portable types, turn-over hand-squeezers, ramming machines, pattern-drawer machines and rock-over-drop moulding machines. Further, it may be stated that a constant look-out is kept for any new appliance that may appear in the foundry world, and, for example, the firm were the first in Great Britain to install the electrically driven sand slinging machine. There are the usual sand mixing and tempering machines. Ten hot-air drying stoves are installed in the heavy foundry, varying in size from 36 ft. × 20 ft. × 11 ft. to 33 ft. × 10 ft. × 10 ft., which will take the largest cores and moulds, the floor drying of moulds being entirely eliminated. Each stove is a complete independent unit.

Melting Plant.

The equipment includes a complete lay-out in the various bays of pneumatic and hydraulic pressure mains for supplying the different machines, cranes and tools, and the foundries are served by four cupolas, three of which have a total melting capacity of 36 tons per hour, the remaining one being for experimental and research purposes with a capacity of 1 ton per hour. The air for these cupolas is supplied by two electrically-driven "Keith Blackman" fans, and as showing again the scientific methods adopted, the volume of the air is recorded continuously on a chart by means of the "Cole" pitotmeter. As is well-known, of course, Messrs. Glenfield & Kennedy manufacture a whole range of water meters and similar measuring devices, and one of their specialities in this connection is the "Cole" pitot-meter, which can be used for the continuous recording of any fluid, whether liquid or gaseous.

Further, it may be mentioned that all the cast iron borings and turnings are carefully collected, from the extensive machine shops and are bricketted in the foundry department by a special process, so that these form a part of the daily charge for the cupolas, an economical method which serves the purpose also of improving the quality of the cast iron, as Messrs. Glenfield & Kennedy have found by experiment and experience.

The foundries are surrounded by a spacious stock-yard, together with a broad-gauge railway, on which are operating two of the firm's locomotives, one carrying a special jib crane attachment for the transport of heavy moulding boxes and castings. The complete works, of which these foundries form a part, cover 23 acres, employing over 2,000 people, whilst the valve department alone is equipped for an annual output of 80,000 valves of every class.

Institute of British Foundrymen.

Production of Castings in Permanent Moulds.

With reference to Messrs. R. J. Anderson and M. E. Boyd's Paper on the above subject, Mr. Thos. McFarlane has sent the following contribution to the discussion. He asks: (i) Whether it is practical to cast 5½ in. long by 4½ in. outside dia. by ½ in. thick bushes in permanent moulds, using a collapsible core; (ii) if it is possible, what thickness of mould is suitable? (iii) what is the best dressing for use with non-ferrous castings? and (iv) is a high casting temperature desirable?

THERMIT, LIMITED, are now manufacturing a high-grade anti-friction metal, which will be known as the "Eel" Brand.

American Government Specify Pig-iron by Rule.

A specification for foundry pig-iron has been adopted by the American Federal Specifications Board for the use of the departments and independent establishments of the Government in the purchase of pig-iron. It became mandatory on July 1, 1924, but was open to be put into effect at any earlier date desired, by any department. The specification is as follows:—

GRADES.

1. Foundry pig-iron shall be furnished in grades 1 to 4 inclusive, unless otherwise stated in the contract or purchase order.

MATERIAL.

2. The material shall be in accordance with the requirements contained in the following paragraphs:—

GENERAL REQUIREMENTS.

3. (*a*) The pigs shall be free from excessive sand or slag.

(*b*) Not more than 12 per cent. of sow iron shall be accepted in any shipment of any grade, and such sow iron shall be of a size easily handled.

DETAIL REQUIREMENTS.

4. (*a*) Pig-iron of the regular grades shall conform to the requirements as to chemical composition specified as follows:—

	No. 1.	No. 2.	No. 3.	No. 4.
Silicon, per cent. ..	2.75–3.25	2.25–2.75	1.75–2.25	1.25–1.75
Sulphur, maximum	0.04	0.05	0.05	0.05
Total carbon, minimum ..	3.40	3.20	3.20	3.20
Manganese	0.50–1.00	0.50–1.00	0.50–1.00	0.50–1.00
Phosphorus	0.50–0.80	0.50–0.80	0.50–0.80	0.50–0.90

(*b*) Pig-iron of special grades shall conform to the requirements as to chemical composition specified in the contract purchase order, and in such cases the following variations shall be allowed:—

Silicon ± 0.25 per cent.
Manganese ± 0.20 per cent.
Phosphorus ± 0.10 per cent.
Sulphur, maximum as specified.
Total carbon, minimum as specified.

Inspection and Tests.

5. (*a*) One pig shall be taken for every four tons in the lot, chosen from different locations so as to represent as nearly as possible the average quality of the lot. A lot shall always consist of pigs from the same casts, no mixing of iron from several casts being permissible.

(*b*) The pigs selected for test shall be broken so as to present a clean fracture over the cross section of the pig. One-half of each pig shall have drillings taken from three points triangularly spaced on the clean part of the fracture. An equal proportion of drillings from each pig of a lot shall be thoroughly mixed, and analysis made from this sample. No resampling will be permitted.

(*c*) The inspector shall obtain not less than 6 ozs. of the sample, taken and mixed as above, for analyses. In case the first analysis shows that the material does not conform to the specifications, a check analysis shall be made. The average of these analyses shall be considered final.

PACKING AND MARKING.

6. Shipment shall be marked as required by the contract or purchase order.

NOTES.

7. (*a*) Bidders shall state whether the iron they propose to furnish is machine cast or sand cast.

(*b*) Other things being equal, preference will be given to machine-cast pig-iron.

Suitable methods for Umpire Chemical Analysis are being developed, and will be included as an appendix at a later revision.

Objects of a Cost System.*

BY W. B. GREENLEE.

Considerable confusion exists amongst grey-iron foundrymen, particularly those not operating a complete costing system, because of the variety of methods suggested for computing costs.

In foundry cost finding there are two main objects :—

First.—An analysis of accounts for the purpose of reducing costs and eliminating waste in the foundry as a whole.

Second.—The determination of the costs of castings by classes, customers or patterns.

All foundrymen should use some method for obtaining an analysis of their costs so that better control of operation can be obtained. Those foundries desiring additional costs by class, customer or pattern should use some further methods for obtaining this additional information.

For a small foundry making only one class of castings and where the first object is sufficient, a cost system can be easily installed. No printed forms are necessary and all that is required is to understand the principles involved, and to use reasonable care in keeping the different costs separated. If the results are kept monthly, as is usually the case, it is necessary to have an inventory at the beginning of the month of the chief items, such as pig-iron, coke, scrap, etc. To these inventories are added the receipts during the month of these respective items and at the end of the month the inventories are deducted. This gives the consumption. This consumption may also be obtained by weighing all new materials used during the month. The production is obtained by adding to the shipments during the month the finished castings on hand at the beginning of the month and from this sum deducting the inventory of finished castings on hand at the end of the month. This gives the number of pounds of good castings produced.

By dividing the cost of each of the items consumed by the production in pounds of good castings produced the cost per pound is ascertained and can be compared month by month.

With data available under this system a number of ratios can be used to control the operation of the foundry. For instance, the number of men in the cleaning room should vary with the melt, the common labourers should vary with the melt or the number of moulders, the ratio of core oil to core sand used could be checked for the month, etc.

While the costs can be ascertained roughly independent of the books, it is usually best to have ledger accounts for those items of which track is to be kept. The essential accounts are as follows :—Pig-iron, purchased scrap, coke cupola expense, cupola labour, core room moulders, core room common labour, core room expenses, cleaning labour, general foundry expense, cleaning moulders, cleaning labour, administrative and general expenses.

Those accounts can be sub-divided indefinitely according to the information desired. The main point is to get in all costs of doing business.

For obtaining costs by class, customer or pattern the same accounts are kept, but in addition, it is necessary to keep a record of the time taken by the moulders and coremakers on the work to be costed and the production of castings for each customer or class.

The larger the number of customers and the greater the variety of work the more it becomes necessary to use greater accuracy in cost finding.

For the smaller foundry the method is not complicated, and no special forms are necessary except the sheet or card used for collecting the time of the moulders.

A simple method is to get *three rates*—a rate per pound, a rate per hour of moulders' time, or in the case of pieceworkers a percentage of their wages, and a rate covering the expenses of the core room.

1. The tonnage rate is ascertained by dividing the costs which are considered proportional to weight, such as the metal and cupola costs, moulding sand used, cleaning, etc., by the total pounds of good castings produced.

2. The overhead rate for moulders and coremakers is obtained by dividing such expenses as are roughly proportional to labour by the hours or amount of moulders' and coremakers' wages.

3. The coreroom overhead rate is added to the above rate and is obtained by dividing the core-room costs by the productive hours or wages of the coremakers.

There is an advantage in putting some of the expenses on a tonnage basis and some on the direct labour, since errors in estimating can be rectified to a certain extent by this method rather than by having all of the costs spread over either tonnage or labour.

As soon after the first of the month as the information is available the cost record is made out. Cards or preferably a columnar sheet is used.

Columns are provided for :—(1) Production by pounds; (2) multiply above by tonnage rate; (3) moulder's wage; and (4) overhead on moulders' wages.

If there is core work the following columns are added :—(5) Coremakers' wages and (6) overhead on coremakers' wages.

An additional column is also provided for a total of all of the cost entries shown above.

The sum of all these entries is the cost of the customer's work for the month. This divided by the number of pounds produced for the customer gives the cost per pound, which can be compared with the selling price to get the profit and loss.

Cost Data.

In "The Economics of Overhead Costs," by J. Maurice Clark, book published in 1923, by University of Chicago Press, the author states that the ten purposes of cost accounting are :—

1. To help to determine a normal or satisfactory price for goods sold.
2. To help to fix a minimum limit on price cutting.
3. To determine which goods are most profitable and which are unprofitable.
4. To control inventory.
5. To set a value on inventory.
6. To test the efficiency of different processes.
7. To test the efficiency of different departments.
8. To detect losses, wastes and pilfering.
9. To separate the "cost of idleness" from the cost of producing goods.
10. To "tie in" with the financial accounts.

* Mr. Greenlee is the chairman of the American Foundrymen's Association Committee on Foundry Costs, and this statement is taken from the Association's Bulletin.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to A. E. Sherrey, as liquidator of Joseph Evans & Company, Limited, Liverpool Street Mills, Liverpool Street, Birmingham, and J. L. Vitoria, 91, Bishopsgate, London, E.C.3.

FOLLOWING upon the death of Professor J. G. Longbottom, head of the Department of Mechanics, the Governors of the Royal Technical School, Glasgow, have decided to amalgamate the Departments of Mechanics and Mechanical Engineering under Dr. A. L. Mellanby, who will in future be the Professor of Mechanics and Mechanical Engineering. As Associate Professor in the same Department, the Governors have appointed Mr. William Kerr.

IN REGARD to the proposal to form the Internal Combustion Engine Development Company by Richardsons, Westgarth & Company, Limited, Wm. Beardmore & Company, Limited, Furness, Withy & Company, Limited, and Tosi, Italy, it has been decided to build two large Diesel engines, one at Richardsons, Westwarth's works at Hartlepool, and the other at Beardmore & Company's works at Dalmuir. A very large sum is involved in the formation of the Development Company.

THE REPORT of the Tees Conservancy Commission shows that the pig-iron brought into the Tees during the eight months ended June 30 totalled 15,740 tons, against 5,557 in the corresponding period of 1922-3 and 213 tons in the pre-war period. Semi-finished products imported in the last eight months reached 50,560 tons, compared with 49,881 a year ago and 30,307 in the pre-war period; and plates, bars, angles, rails, sheets, and joists unloaded to the end of last month amounted to 12,081 tons, against 8,549 a year ago and 17,419 in the pre-war period.

The Development of Alloy Steels.

By Sir Robert Hadfield, Bart., F.R.S.

In this Paper, read before the Iron and Steel Section of the Empire Mining and Metallurgical Congress at the British Empire Exhibition at Wembley, SIR ROBERT HADFIELD, BART., entered upon a comprehensive survey, largely historical, of the development of alloy steels and the important position they have attained in the metallurgical and engineering industries. Very aptly he remarks that following on the Iron Age, which merged into the Steel Age, when Bessemer and Siemens discovered their processes for manufacturing steel, so there has since developed what may be called the Era of Special Steels. Reviewing the numerous researches that have been undertaken in connection with the subject, the author justly states that whilst fully recognising the merits of those who have carried out researches of this nature in other countries, the honour can be claimed for Great Britain of having in the main inaugurated the era of alloy steels. In point of fact, as the leading metallurgists of other countries have unanimously admitted, the author's own discovery of manganese steel was practically the starting-point for most of our present-day knowledge concerning alloy steels and their technology. That the industry is largely indebted to Sir Robert Hadfield's own efforts is amply demonstrated by the fact which he records that he has contributed some 140 papers extending over nearly forty years to various societies and institutions, adding much to our knowledge concerning various alloy steels and other metallurgical advances. The facts disclosed by these researches remain as correct and useful to-day as they were at the time of their discovery. Finally, the author can claim to have been a true prophet in regard to the ever-increasing importance of alloy steels, for in his Paper on "Alloys of Iron and Chromium," read before the Iron and Steel Institute in 1892, he used the following words: "The author cannot but think that the special question of steel alloys or combinations will be eventually found to possess considerable practical importance to the world at large, and perhaps be the means of eventually enabling our civil and mechanical engineers to design and carry out works of a magnitude which, notwithstanding the great strides made during the last few years, even at present are not possible." The truth of this forecast, made thirty years ago, has since been demonstrated in the most convincing manner.

The wonders of modern engineering (continues the author) depend, more closely perhaps than is generally realised, upon the special qualities of the materials employed. Engineering science has progressed satisfactorily just so far as the properties of the constructional materials available would permit. Improvements in materials have been followed immediately by advances in engineering practice—as witness the striking development which followed the introduction of manganese steel and silicon steel. On the other hand, the limitations of available materials impose from time to time a check upon advance in other directions. Such indeed has been the chief difficulty in the way of the extended use of high-pressure high-temperature steam-turbines, and the perfection of the internal-combustion turbine; these developments have now been rendered possible by the discovery of steels which will withstand higher temperatures and higher stresses than the alloy steels hitherto known. Such products are now being very carefully studied, and, thanks to the work of M. Chevenard in France, great advances have resulted in this respect. The author is at present engaged,

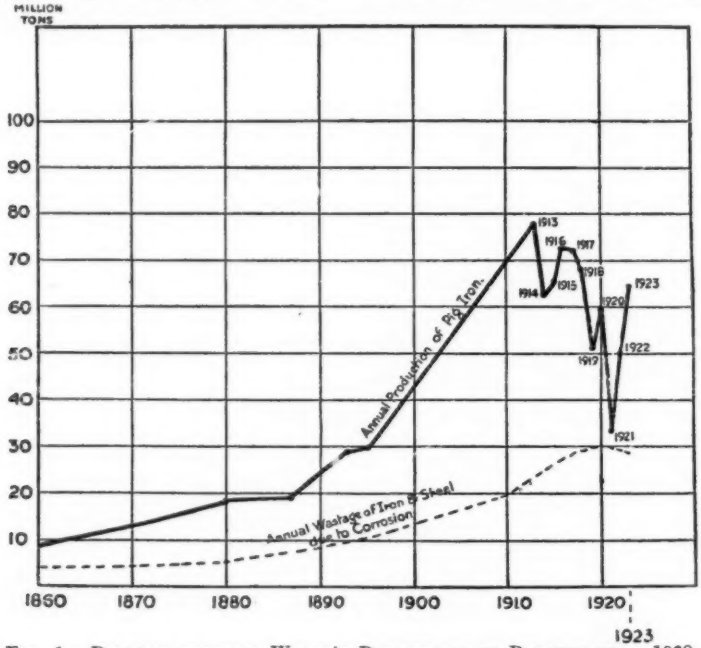


FIG. 1.—DIAGRAM SHOWING WORLD'S PRODUCTION OF PIG-IRON FROM 1860 TO 1923, AND ANNUAL WASTAGE OF IRON AND STEEL RENDERED UNSERVICEABLE BY THE EFFECTS OF CORROSION.

with his acquiescence and assistance and that of his company, in a number of investigations on these lines. There have already been produced remarkable steel alloy combinations, which even at the high temperature of 900 deg. C. possess no less than 18 tons tenacity. These materials can also be heated in an oxidising flame to 1,000 deg. C., or even higher, and scarcely show any oxidation.

Whilst, owing to the mass of research work already carried out, to those on the outside fringe of this line of work it may seem that there is room for no more or few new steel alloys to be discovered, yet the field is still very wide for fuller examination of those alloys already known. Reference may be made to the important work now being planned and carried out by the Alloys Research Committee, formed to deal with iron and its alloys. Much credit is due to the able Chairman of this Committee, Sir John Dewrance, who is devoting considerable time and attention with a view to organising this further source of research work, aided as he is by the members of the Committee, which includes Dr. W. Rosenhain, F.R.S.; Professor H. C. H. Carpenter, F.R.S.; Sir Thomas Kirke Rose; Mr. F. W. Harbord; and the author.

It is hoped aid will be afforded generously to the efforts being made by the Chairman and his colleagues to carry on this important work. The Council of Scientific and Industrial Research is generously assisting these important investigations. The Royal Society, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Armourers and Braziers Company, Sir John Dewrance himself, and Messrs. Babcock & Wilcox, have also each contributed £500. Some of these have since doubled their donation.

Alloy Steels and the Conservation of Iron.

Under this heading the author points out that apart from their importance in providing mechanical and physical properties otherwise unattainable, alloy steels are of enormous importance in relation to the conservation of iron. It was stated recently by the well-known geologist, Professor J. W. Gregory, F.R.S., that if the world's consumption of iron and steel went on increasing at the same rate as before the war the supply of iron ores would probably be exhausted within 130 to 150 years. Such a prospect demands serious consideration, for we are to some extent stewards for the future; also, an increasing scarcity of iron ores would lead to a serious rise in prices long before the shortage became acute. Conservation of iron, both by reducing the quantity of iron used for a particular purpose and by reducing the wastage due to corrosion, is a problem of immediate economic importance; also it is one in the solution of which alloy steels will play a great and useful part; for example, one ton of manganese steel will do the work of about ten tons of ordinary iron or steel, owing to its remarkable durability in heavy service. Thus the use of alloy steels secures other advantages of even greater importance than the saving in the amount of iron used.

The chart (Fig. 1) shows the world's production of pig-iron from 1860 to 1923, also the annual wastage of iron and steel rendered unserviceable by the effects of corrosion. It will be seen that the amount of iron and steel thus going out of use in 1921 was nearly equal to the quantity of pig-iron estimated to have been produced in that year, and about 40 per cent. of the maximum annual production before the war. Here again, with our present-day knowledge of rust-resisting iron and steel, and with further knowledge which we hope to acquire, the use of alloy steels should make possible important savings in the consumption of iron. In the United States alone the weight of alloy steel products increased from 181,980 tons in 1909 to 1,787,852 tons in 1918, from which figures it is evident that the tonnage of special steels is amply sufficient to affect appreciably the conservation of iron.

Historical Survey.

The author then enters upon a historical survey of his subject, in the course of which he gives some interesting information about the attempts of Faraday and other early experimenters to make alloy steels. He points out that Heath, who (about 1840) applied black oxide of manganese to the making of crucible cast steel, was probably the first to recognise fully the utility of manganese in the manufacture of steel. The commercial production of rich ferro-manganese was commenced by Henderson, of Glasgow, and Prieger followed on the same lines, but it was to the work of the Terre Noire Company that the first production of a rich and cheap ferro-manganese was due. This product made possible the wholesale manufacture of excellent soft steels, and, as the use of "high" ferro-manganese, containing up to 80 per cent. of manganese, was essential to the commercial manufacture of manganese steel, the Terre Noire Company rendered a doubly valuable service to metallurgy by improving and cheapening the supplies of "ferro." The exhibits shown by the Terre Noire Company at Paris in 1878 were accompanied by an instructive pamphlet showing the influence, as then practised, of different bodies alloyed with iron and suggesting further investigations. Amongst these were the experiments with varying percentages of manganese, up to 2.5 per cent., but no higher percentage was mentioned. At this point, owing to the brittleness of the product, whether cast or forged, the series was stopped, for it was assumed—erroneously, as events proved—that further additions of manganese would only produce still more harmful effects.

The author relates how he translated the whole of the Terre Noire Company's pamphlet, and how it was probably due to the impression made on his mind by this pamphlet that he was inspired by the results—both positive and negative—obtained by the Terre Noire Company, to carry on the series of researches into alloys of iron and other elements which then followed at his hands and finally resulted in the important invention of manganese steel.

Having briefly surveyed the evolution of early rust-resisting steels, the author deals with some of the more notable experiments demonstrating the vitally important part played by carbon in the alloys of iron. On this subject, which has roused so much contention, the author has advanced, during a period of many years, a mass of evidence which he has collected and now summarises. The constituents of alloy steels, as revealed under the microscope and as determining the physical properties of the metal, are essentially those of carbon steel. In other words, though the chemical compositions of alloy steels differ widely from those of simple carbon steel, the main effect of the special elements is to enable the physical properties of carbon steel to be developed to a degree otherwise unattainable, or maintained under conditions which would alter them were the special elements not present. The carbon in "alloy steels" is as essential as the special elements, though the percentage of the latter is often much higher than the percentage of carbon. Some effects of the special elements cannot be explained as effects exerted upon the influence of the carbon, but, in regard to the effects of special elements in binary alloy steels (iron, carbon and one special element), it is possible to trace a more or less definite relation between the percentage of the special element and the percentage of carbon.

Referring to the importance of heat-treatment, the author points out that to-day it is generally recognised that proper heat-treatment is essential to the development of the best characteristics in most steels with but few exceptions, and that the heat-treatment to be adoped for various applications is specified as a matter of course. The author's discovery that manganese steel was toughened by water-quenching—instead of being hardened, as in the case of carbon steels—afforded a striking proof of the importance of heat-treatment, though it was many years before this question received the full consideration which was its due. The fact that heat-treatment is an essential factor in the preparation of alloy steels for service, and the remarkable results thus obtained, led to an increased appreciation of the possibilities of heat-treatment in connection with carbon steels. The advance in knowledge concerning alloy steels reacted, in fact, upon the technology of carbon steels and led to the discovery of the fact that properly-treated carbon steels are comparable with the more expensive alloy steels in many applications.

In a special Section devoted to the subject of manganese steel the author enlarges upon its special characteristics, its manufacture and working, its heat-treatment, and its mechanical and other properties. In a further Section he devotes some further observations to the subject of silicon steel, recalling how it was found that a steel containing about 3 per cent. of silicon had higher permeability, lower hysteresis loss and lower eddy current loss than pure iron. The lower eddy current loss is due to the higher electrical resistance of the silicon alloy, viz., from 10 to 12 microhms per cm.-cube higher than that of pure iron, per 1 per cent. of silicon in the alloy. The maximum permeability of rolled sheets of 2½ per cent. silicon steel is 25 per cent. higher than that of pure iron, whilst the hysteresis loss is initially about two-thirds that of pure iron and *decreases* during a period of years in service. This property of improving during use is in marked contrast to the behaviour of charcoal iron and the early dynamo and transformer steels, for the hysteresis loss in these materials often increased by 100 per cent. or more after a few months, and necessitated the dismantling and annealing of transformer plates.

XUM

Expressed in the units familiar to electrical engineers, the advance effected by silicon low-hysteresis steel may be stated as follows: The best transformer plates available about 25 years ago were of Swedish charcoal iron, and these had a maximum permeability of about 4,000 and a hysteresis loss of 3,000 ergs per cm.-cube per cycle when tested at a maximum induction of 10,000 gauss and a frequency of 60 cycles per second. "Lohys," a type of mild steel made by Messrs. Sankey, had a maximum permeability of 3,800 and a hysteresis loss of 3,000 ergs per cm.-cube per cycle under the same conditions. Both of these materials are subject to serious "ageing," whereas the author's silicon low-hysteresis steel, made by Messrs. Sankey under the name "Stalloy," actually improves with age. "Stalloy" has higher permeability than iron for inductions below saturation, and its coercivity and retentivity are nearly 50 per cent. lower than those of pure iron. The alloy containing from 3 to 4 per cent. of silicon can now be made with a total loss only slightly exceeding 1 watt per kg.; when tested at 10,000 gauss maximum induction and 60 cycles per second, and a permeability of 8,000 can be reached.

Modern Alloy Steels.

Arranged in order to atomic weight (continues the author), the elements which have been more or less thoroughly investigated in relation to their effects on iron are as follows: Boron, carbon, aluminium, silicon, phosphorus, sulphur, titanium, vanadium, chromium, manganese, nickel, cobalt, copper, arsenic, zirconium, molybdenum, silver, tin, cerium, tantalum, tungsten, bismuth, uranium. Total binary alloys, 23. The number of possible ternary alloys (two other elements with iron) is 253, and the number of possible quaternary alloys (three other elements with iron) is 1,771. The total number of possible ternary and quaternary alloys is thus 2,024, using only the 23 elements mentioned, and the complete investigation of this field will inevitably occupy many years.

Proceeding to review the extent and variety of the different applications which have been found for alloy steels in modern industry and for domestic purposes, the author takes the various fields of utility for steel and indicates the extent of the invasion of alloy steels in each direction, such alloy steels serving various purposes, according to their special characteristics.

Taking first non-corrodible steels, he first classifies the types of corrosion usually encountered in practice and then proceeds to deal in turn with rustless steel, rustless iron, pure iron, and alloys resisting special forms of corrosion. Regarding the last-named, he points out that widely divergent opinions have been expressed concerning the value of copper in steel as a prevention of corrosion, these differences being probably attributable to the effect of copper varying greatly with the corrosive agencies concerned. It is a remarkable fact that ordinary mild steel containing so little as ¼ per cent. (one part in 400) of copper has greatly improved resistance to attack by sulphuric acid and by the sulphurous atmosphere of industrial districts. Steels containing 14 or 15 per cent. of silicon combine high resistance to corrosion by commercial acids with sufficiently good mechanical properties to enable them to be used for containing vessels, pipes and fittings in the manufacture and handling of acids and other chemicals. The addition of nickel to carbon steel generally reduces the corrodibility of the metal very appreciably, and it is found that boiler tubes containing 30 per cent. of nickel last about twice as long as mild-steel tubes. Steel containing 22 per cent. of nickel resists many corrosive agents, and it is used for valve parts exposed to salt water and for the electrodes of sparking plugs. With higher percentages of nickel the alloys remain resistant to corrosion, tough and dense, and the coefficient of thermal expansion decreases until the percentage of nickel reaches 36 per cent., beyond which it rises again. Nickel-chromium steels resisting the corrosive action of the atmosphere, sea-water and certain acids and gases, contain from 10 to 15 per cent. of chromium, with 1 to 3 per cent. of nickel, or from 20 to 23 per cent. of chromium with 6 to 9 per cent. of nickel, the carbon content being from 0.1 to 0.3 per cent. in both cases. These steels have a tenacity of about 50 tons per sq. in., and a satisfactory elastic limit and ductility. The first-mentioned one has been used for turbine blades, and the second one (with the higher percentages of nickel and chromium) for valve spindles.

Nickel steel containing from 3 per cent. to 7 per cent. of nickel has been used extensively for the blades of steam-turbines, and, in some cases, with very satisfactory results. Bronze is used in some instances, and nickel steels containing about 30 per cent. of nickel have been used, though not with complete success. High-chromium steel has shown itself to be capable of excellent results, but the necessity for heat-treatment is an important disability, because this may be upset in the assembly of the turbine, which often involves brazing, welding, or even casting the blades in the disc. Also, unless the surface of the blades be very highly finished, surface defects act as centres of corrosion.

Heat-Resisting Non-Scaling Steels.

On the subject of heat-resisting non-scaling steels, it is remarked that in order that a steel may be termed "heat resisting" in the sense here intended, it should retain useful mechanical properties at high temperatures, and should be subject to little or no "scaling" when exposed to high temperatures in an oxidising atmosphere. It is well known that, at temperatures above red heat, ordinary steels become plastic and possess little strength, so that they cannot be relied on to sustain the slightest load at such temperatures. In addition, the oxidation or scaling effects at such temperatures often lead to great wastage of material and involve frequent replacements. Such action, in fact, may be regarded to some extent as a corrosion effect greatly enhanced by increased temperature. These failings of ordinary steel handicap the engineer in his progress in many directions, and the removal of these limitations by the use of alloy steels constitutes another worthy object for the metallurgist. High-chromium steel possesses useful characteristics in both these directions, maintaining a considerable degree of strength, and scaling to a much less degree than ordinary steel up to moderately high temperatures. The strength of this steel falls away rapidly at temperatures above 650 deg. C. and it practically loses its non-scaling characteristics at 850 deg. C. Steels of the type used for high-speed cutting tools, including those of the tungsten-chromium and cobalt-chromium types, retain a high degree of strength up to about 650 deg. C., but, as in the case of high-chromium steel, their strength falls away rapidly at higher temperatures. The addition of silicon, in amounts up to about 3 per cent., has been found to produce a marked improvement in high-chromium steel, especially in non-scaling characteristics, and in addition to improve its strength to some degree at high temperatures. Beyond, however, about 800 deg. C. the qualities are still below practical requirements in many directions.

It is not possible to particularise with any freedom the various types of alloy steels used in the construction of modern armament and ordnance. However, in the main it may be said that nickel-chromium steels containing not more than about 4 per cent. of nickel and 2 per cent. of chromium with, in some cases, certain modifications, have figured largely. The qualities of this type of alloy steel are well known and made use of in general engineering applications. Nickel steels containing 5 per cent. or more nickel and 0.3 to 0.4 per cent. carbon are highly resistant to shock, and these alloys are used for the shield-plates of field-guns and for other purposes where resistance to impact is required. Nickel-chromium steel when suitably treated develops hardness, toughness and strength which make it useful for armour plates, but the possibilties in this direction have been surpassed by the nickel-chromium armour-piercing projectiles manufactured by the author's firm. These projectiles, in calibres up to 18 in., are capable of passing undamaged through the thickest armour afloat, even with an oblique angle of incidence, and indeed have constantly done so in practice.

In structural work as distinct from machinery, *e.g.*, in the steel frames of buildings, and in bridges and piers, the use of alloy steels has hitherto made comparatively little headway.

Doubtless the large quantities of steel used in some of these constructions, and the enormous cost of these works, demand earnest consideration before any change of practice can be introduced, and a high degree of conservatism is necessary. The design of still larger bridges must necessarily be based upon the performance of existing structures, and the introduction of new and untried materials, however suitable their qualities appear, may be difficult and uncertain without experience of their actual use over a period of years. For this, if for no other, reason the construction of a bridge in high-tenacity steel would require a great deal of courage on the part of the engineer whose reputation depends upon the success or failure of his work. Apart from these considerations, the working up of alloy steels into large rolled sections for girders and plates would require modifications in existing plants. Progress in this direction, therefore, however suitable the qualities of certain alloy steels may appear, must necessarily be very gradual, and the position as regards ship construction is somewhat similar. Nickel steels are particularly valuable for structural purposes, the addition of nickel to carbon steel resulting in an increase of strength, ductility and toughness, and a higher ratio of elastic limit to ultimate strength. The nickel steels, containing from about 1 to 10 per cent. of nickel and from 1.65 per cent. down to zero carbon, resemble carbon steels, but are superior to the latter. The alloys within this range are of great practical value. Steels containing from 2 to 4 per cent. of nickel and from 0.2 to 0.5 per cent. of carbon are used extensively for constructional purposes. A steel containing 3½ per cent. of nickel and 0.25 per cent. of carbon has the same tensile strength as a 0.45 per cent. carbon steel, and an elastic limit about 60 per cent. of the ultimate strength as compared with 50 per cent. for the simple carbon steel. Nickel steel is tough under impact, and its ductility is well preserved at low temperatures, even down to the temperature of liquid air. The resistance to fatigue is particularly marked, and this is a specially valuable property where structural applications are concerned.

The combined effect of nickel and chromium in nickel-chromium steels is to produce a material with excellent physical properties, well-suited to a great variety of structural applications. According to the conditions to be met, from 1.25 to 3.0 per cent. of nickel and from 0.6 to 1.25 per cent. of chromium are employed, the ratio of nickel to chromium being approximately 2½ to 1, and the percentage of these elements being higher for higher working stresses, particularly in regard to dynamic loads. The general effect of nickel and chromium when used together is to raise the elastic limit of steel and increase its ductility, hardening power and resistance to wear. Heat-treatment is required to develop fully the properties of these alloys, and maximum strength combined with satisfactory ductility is obtained in the air-hardening steels which contain more than 5 per cent. total of nickel, chromium and carbon. The high qualities obtainable in alloys of this type are exemplified by a nickel-chromium steel recently made by the author's firm with the following properties: Tenacity, 108 tons per sq. in.; elastic limit, 90 tons per sq. in.; elongation, 15 per cent. with 51 per cent. reduction of area; ball hardness, 477; and Frémont shock test, 5.3 kg.-m. with 70 deg. angle of bend. The high value of the impact test figure is indicative of the dynamic strength which makes nickel-chromium steels so useful for parts which have to resist shock and live loads.

Leaving out of consideration manganese steel, high-tenacity engineering steels are mainly, but by no means invariably, of the chromium, nickel or nickel-chromium type, sometimes with the addition of other elements. The addition of chromium, in the presence of carbon, to steel has the effect of hardening the metal and reducing the tendency to granular structure. In conjunction with nickel or vanadium, this element gives alloys which are exceptionally strong and resistant to wear, yet can be machined easily. Such steels are therefore employed for high-class gearing, the crankshafts of internal-combustion engines, and other special parts of machines. In all cases, correct heat-treatment is essential to the development of the advantageous properties of chromium steels. Even a small percentage of chromium improves the homogeneity, strength and wearing qualities of steel and increases the elastic limit to 80 per cent. or more of the ultimate strength without appreciable loss of ductility. Chromium steels containing from 0.5 to 3.0 per cent. of chromium, and from 1.3 to 0.3 per cent. of carbon, are used for various constructional components in which hardness, combined with toughness and strength, is required.

Where wear and abrasion are the primary considerations, apart from manganese steel, plain chromium steel with a comparatively low percentage, 1 to 2 per cent. of this element, has proved itself of considerable service in the form of both castings and forgings. A high-tenacity steel, hard, tough and resistant to wear, suitable for use in the balls, rollers and races of ball and roller bearings, contains about 0.8 to 1.0 per cent. of carbon and 1.2 to 1.6 per cent. of chromium. Its ultimate strength may be as high as 130 tons per sq. in., when the metal is suitably heat-treated.

Though there are certain difficulties in the manufacture and working of vanadium steels, these alloys are employed successfully for special shafts, gears and tools for punching, shearing, drawing, etc. Their uses will probably extend, the general effect of vanadium in conjunction with proper heat-treatment being to improve the structure of the steel and increase the resistance of the metal to shock and fatigue.

Discussion.

COL. N. T. BELAIEW, C.B. (London), said the work on alloy steels by Stoddart and Faraday had a very wide repercussion in many countries outside their own, and in the 'twenties was considered of paramount importance. In the 'twenties in Russia, for instance, the work of Stoddart and Faraday gave rise to the whole range of experiments made by Anossoff, who tried to explain the properties of carbon steels on the theory that carbon steel was an alloy steel, and only by degrees came to the conclusion that carbon steels were not alloy steels, and that their properties were to be traced to carbon.

DR. W. H. HATFIELD (Sheffield) said that in the section of the Paper relating to steels for steam-turbine blades it was suggested that the necessity for heat-treatment in the case of non-rusting steel was an important disability. He would not like that to pass without comment, because 40 per cent. chromium stainless steel was being used largely, and if one were to go round the Engineering Section of the Exhibition one would see that for turbine blades it was being largely used. It did not require heat-treatment after it reached the engineer. The material was fully heat-treated before it went to the engineering works, so that the engineer had nothing to do but machine the blade to shape and insert it in the turbine. Therefore the distortion effects did not arise. The author said that unless the surface of the blades was very highly finished surface defects would act as centres of corrosion. He (the speaker) quite agreed, but whether the finish were excellent or indifferent he submitted that the defects would always cause corrosion, and it was essential that all that material should be free from any defects, and particularly from surface defects arising from the non-removal of scale surfaces produced in manufacture.

PROFESSOR C. H. DESCH (Sheffield University) said it was rather striking to notice that the number of metals which could be usefully alloyed with iron was, after all, comparatively small. The work which had been done in America in attempting to make alloy steels by the use of some of the rarer metals had shown that nothing was to be gained by the use of such metals, and one noticed that with the exception of vanadium all the metals which could be usefully alloyed to iron to form steel were quite near to iron in their "periodic classification." Vanadium produced its maximum effect with quite a small quantity, and none of the rarer metals seemed to be of any particular use. All those closely related to uranium, which were in the same group—such as chromium, molybdenum and tungsten—although great claims had been made for them, he thought most people would have found very disappointing. That was a point of some scientific interest.

SIR ROBERT HADFIELD, in the course of his reply, drew attention to the somewhat remarkable fact that the four combinations of iron with other elements each involved the percentage of 12. One had 12 per cent., which gave the remarkable manganese steel; 12 per cent. of nickel gave the extraordinary material which Professor Arnold had so well described in his Paper; 12 per cent. of chromium was startling the world at present by its non-rusting qualities; and 12 per cent. of cobalt was also used for an alloy steel.

XUM

Efficient Methods of Preparing Foundry Facings.

A considerable advance in fine grinding machinery in the last few years has been made, and its adoption in many fields where older methods were previously employed has resulted in a distinct decrease in operating costs.

Intermittent grinding has been and still is adopted in many trades, a method which involves a large amount of labour in charging the machine, discharging the ground product, and to this expense must be added the time lost during these operations, in which the machine is not producing, the total time so lost in a year representing a considerable sum.

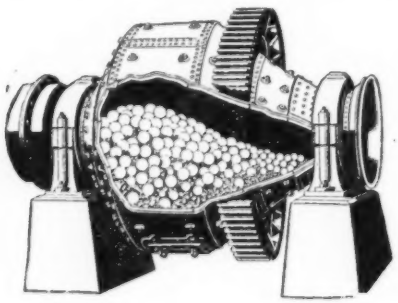


FIG. 1.—THE HARDINGE CONICAL MILL.

The next step was the introduction of mills which were continuous in operation, varying considerably in details of design, but to obtain a clearer perception of the essential difference in these mills they may be divided into two classes, *i.e.*, high speed mills and low speed mills. To the former belong the various types of roller mills and disintegrators, the slow speed mills embracing the several kinds of ball and tube mills.

High speed mills are economical as far as power is concerned, but wear and tear is greater than that of slow speed mills, the grinding efficiency also falling off as the grinding members wear down.

Generally speaking, slow speed mills absorb more power per ton milled, but running expenses are lighter than with high speed mills.

The grindability of the material under consideration often determines the type of grinder to employ. Both high speed mills and slow speed mills are used for grinding comparatively soft materials, but on hard substances the cost of maintenance is greatly in favour of the latter.

A further reduction of operating costs was marked with the advent of the conical mill, which in operation is similar to the ball or tube mill, and is similar in design except as to shape, which consists of two cones connected by a comparatively short cylindrical portion (Fig. 1). This shape plays an important part in reducing the horse-power consumed per ton ground, as by a purely automatic action, due to the conical shape, the grinding media—balls or pebbles—classify themselves according to size; thus the large balls act on the feed as it enters the mill, and owing to the greater peripheral speed, a greater fall is imparted to the balls at this point, and the material is rapidly broken down. As this partially ground material passes to the outlet it is subjected to the attrition of the smaller balls with their relatively greater surface, and thus the energy expended is in proportion to the work to be done.

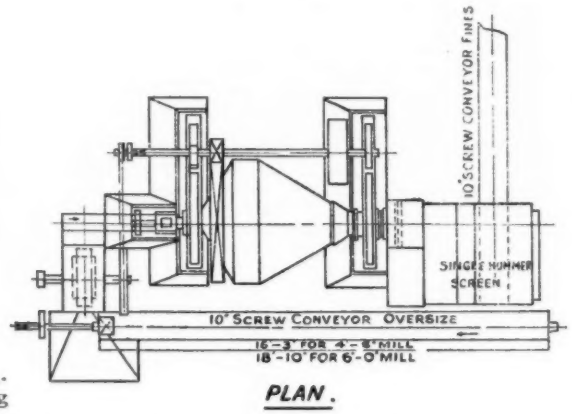


FIG. 2A.—PLAN OF A TYPICAL 1 TO 2-TON PER HOUR HARDINGE CONICAL MILL.

The conical mill is used extensively for grinding abrasives, coke and coal, and anthracite for foundry facings and powdered fuel.

A typical 1-2-ton an hour unit is shown in Fig. 2 as representing an efficient continuous and

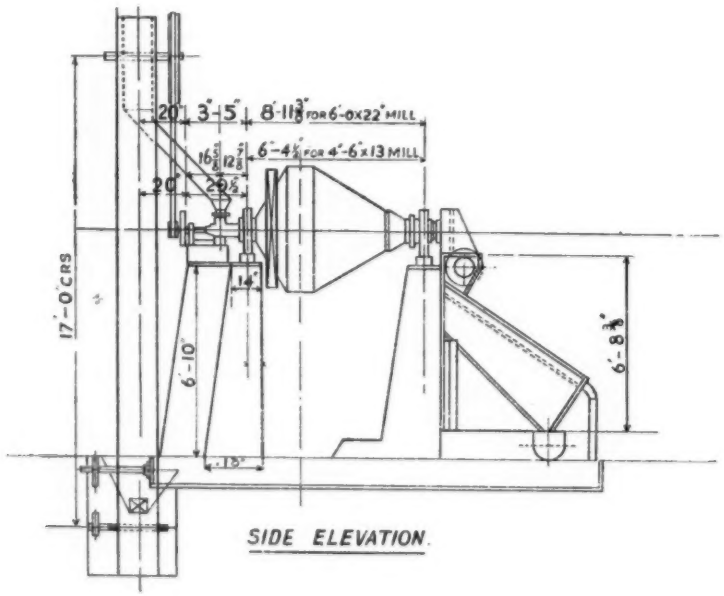


FIG. 2.—SIDE ELEVATION OF A TYPICAL 1 TO 2-TON PER HOUR HARDINGE CONICAL MILL.

automatic means of obtaining products of definite and controlled fineness.

The material to be ground should discharge from a hopper or bin to an automatic adjustable feeder, thence to the mill, which discharges on to an electrically vibrated screen with one or more surfaces, depending upon the number of products desired. Any oversize is returned to the mill, thus only material of requisite fineness is discharged from the circuit.

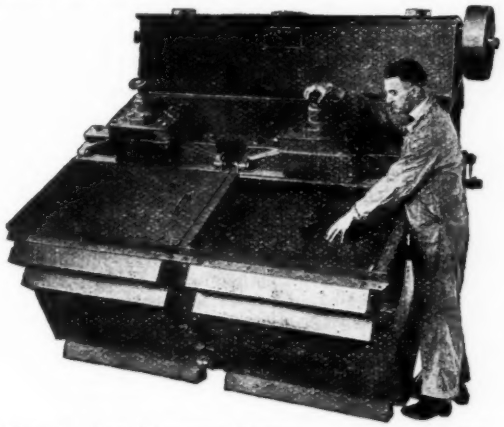


FIG. 3.—THE HARDINGE ELECTRIC SCREEN, SHOWING OPERATOR TURNING HAND-WHEEL ON VIBRATOR TO ADJUST INTENSITY OF VIBRATION.

The current which vibrates the screen is generated by a small generator, which may be driven from an ordinary line shaft.

The screen cloth is subjected to 1,800 vibrations per minute, and this intense vibration keeps the meshes clear and effects a remarkably clean separation. An illustration of the screen in shown in Fig. 3.

American Specifications for Cast-iron Pipes.

After a thorough discussion at a conference in New York on June 5 of the various problems concerned in the proposal to bring about national uniformity in the cast-iron pipe industry, agreement was reached on the following scope for this work:—

(1) Unification and development of specifications for cast-iron pipe, including materials; dimension; pressure ratings; methods of manufacture, including such new developments as centrifugal casting, in so far as they may be necessary to secure satisfactory results in preparation for workable specifications; (2) elimination of unnecessary sizes and varieties; (3) consideration of the possibility of developing a co-ordinated scheme of metallic pipe and fittings applicable to all common mediums (possibly along the lines of the work being carried on in Europe on the same subject); and (4) methods of making up joints in so far as they are determining as to the dimensional design of cast-iron pipe.

The types of cast-iron pipe under standardisation are to include: (a) Flanged pipe; (b) flanged and bell-mouth fittings and wall castings; (c) pipe elbows, tees, Y's, return bends, and other fittings not now included in standard lists; (d) cast-iron pipe threaded for flanges or couplings; and (e) soil pipe and other light types of cast-iron pipe and fittings.

On June 12 the American Engineering Standards Committee ratified the recommendations of the conference that the work be carried out by a sectional committee under its auspices and under the joint sponsorship of the American Gas Association, the American Water Works Association, and the American Society for Testing Materials. The work will be co-ordinated with that of the existing sectional committee on pipe flanges and fittings, already well advanced under the sponsorship of the American Society of Mechanical Engineers, the Manufacturers' Standardisation Society of the Valve and Fittings Industry, and the Heating and Piping Contractors' National Association. —"Iron Age."

Papers to be read at the A.F.A. Convention.

The following papers are expected to be read at the Milwaukee Convention of the American Foundrymen's Association, to be held from October 13 to October 16:—

"Bell Founding," by Wesley Lambert and G. Hall (Institute of British Foundrymen's Exchange Paper).

"Making Copper Castings from Cupola Melted Metal," by T. F. Jennings.

"Founding of Brass in Mexico," by H. H. Miller.

"Art Bronze Work," by J. F. Arnold.

"Broadening the Field for Steel Castings Through the Use of Alloys and Heat Treatment," by F. Grotts.

"Production of Aluminium Alloy Pistons in Permanent Moulds," by R. J. Anderson and M. E. Boyd.

"Aluminium Silicon Alloys," by D. Basch.

"Salvage of Aluminium Alloy Castings by Welding and Soldering," by R. J. Anderson and M. E. Boyd.

"The Electric Furnace and Cast Iron," by E. L. Wilson.

"Making Cast Iron in the Electric Furnace," by E. B. Stearns.

"Melting Malleable Cast Iron in the Electric Furnace," by F. Scott Mackay.

"Relation of Composition to Strength in the A.S.T.M. Bar," by J. W. Bolton.

"Tests of Cast Iron," by J. T. MacKenzie.

"Theoretical Principles of Electric Melting." by Manuel Tama, Berlin, Germany.

Device for Cleaning Castings.

A device for cleaning castings, intended for use where there is no sandblast equipment and on castings that cannot be milled, is shown in the accompanying illustration, from which the component elements of the device may be clearly noted.

The four pieces of cable, which are ¾ in. in diameter and the same material as used on cranes for hoisting purposes, are bent as shown, and are then bolted between the two cast-iron plates. The assembled device, which is shown at the left in the illustration, may be attached to any standard portable electric or pneumatic grinder, and, in addition to the cleaning of castings, it may be used in the cleaning of rust and paint from ironwork

DEVICE FOR CLEANING CASTINGS, USEFUL ON CASTINGS THAT CANNOT BE MILLED, AND WHERE THERE IS NO SANDBLAST EQUIPMENT.

and tanks. According to the "Iron Age," the wire cable strands are durable, but when necessary they may be replaced conveniently in the hub part of the device.

This cleaning tool was devised and patented by William Seilkop, plant engineer, Elmwood Castings Company, Cincinnati. It is being used in the Elmwood Company's foundry, and is said to clean castings efficiently in less time than by previous methods.

THE WESTERN ELECTRIC COMPANY, LIMITED, of Connaught House, Aldwych, London, W.C.2, have established a branch at May Buildings, 51, North John Street, Liverpool.

The Welding of Cast Iron from a Metallurgical Point of View.*

By J. G. PEARCE, B.Sc. (Eng.), M.I.Brit.F., M.I.E.E.

[*Abstract.*]

The properties of cast iron which determine the success or failure of welds, such as melting point, plastic range, shrinkage, mechanical properties, depend to a greater or lesser extent upon the carbon content of the iron. They are affected to some degree by other elements unavoidably present in cast iron, and the influence of these may be direct or indirect through the effect on the carbon or its relation with the iron.

Influence of Rate of Cooling on Structure.

In dealing with the oxy-acetylene welding operation it is very necessary to consider the effect of the rate of cooling, since, unless special measures are taken to prevent it, the high temperature produced by the flame is followed by equally rapid cooling, due partly to the small amount of heat actually communicated to the metal, and partly to the rapidity with which this is conducted away by the surrounding cold mass. The material thus suddenly heated is cooled so quickly that the effect of chilling or quenching from a high temperature is produced, with the result that the structures hitherto shown do not have time to form. In metallurgical research it is a common practice to fix a structure produced at a high temperature by rapid quenching.

The plastic range is very important in cast-iron welding, because with so many constituents with different softening and melting points the operator has opportunities of puddling the material in the weld, so freeing it from impurities and bonding the deposit and base metal, and a skilful welder can enormously increase the chances of success.

White and Grey Iron.

Hitherto no distinction has been made between cast iron and steel. In dealing with the remarkable series of changes which take place it is not necessary. Starting with pure iron, the nearest commercial approach to which is wrought iron, the range of material up to 0.9 per cent. carbon comprises the mild steels and tool steels. High carbon steels for special purposes contain up to 2 per cent. of carbon. The white cast irons contain carbon between 1.7 per cent. and 3 per cent., and consist of the solid solution of carbide in iron, and the eutectic. Grey cast irons contain carbon above 1.7 per cent., and differ from the white irons in having a certain proportion of the carbon present as graphite, the formation of which is discussed below.

Typical analyses of white and grey irons are as follows, the graphite and combined carbon, of course, being equal to the total carbon:—

Grey.—Total carbon, 3.3; graphite, 2.8; combined carbon, 0.5; silicon, 2.5; manganese, 0.50; phosphorus, 0.60; and sulphur, 0.10 per cent.

White.—Total carbon, 3.2; graphite, —; combined carbon, 3.2; silicon, 0.8; manganese, 0.45; phosphorus, 0.20; and sulphur, 0.15 per cent.

Whether the iron is grey or white depends on the condition of the carbon, and this depends very largely upon the way in which the iron has been cooled. Sudden cooling retains the carbon as solid solution and carbide, and the iron remains hard, white, and brittle. If the cooling is slow, the solid solution and carbide decompose into their constituents, ultimately iron and carbon, and the latter appears as graphite. The slower the cooling the more coarse become the graphite flakes. Furthermore, it has been found that silicon prevents combination between iron and carbon, and by suppressing the formation of carbide makes the iron grey and soft, the carbon appearing again as graphite. Silicon is used by founders as a means of controlling the iron and making it soft and machineable.

There is no sharp line of demarcation between grey iron and white iron. A white iron which contains much free carbide will be such that no amount of heat treatment will soften it. Neither can an essentially grey iron be made white by heat treatment. The irons between the extremes, however, are grey or white, according to the rate of cooling and the percentage of silicon. Normal cooling in the foundry is rather slow, especially if the mass of casting is heavy, and to make the iron white and hard requires artificial chilling.

Other Elements in Cast Iron.

Certain other metallic elements, notably aluminium and nickel, have a graphitising effect similar to that of silicon, but the cost of these metals and the ease with which silicon-bearing pigs are obtainable makes silicon the general favourite for the particular purpose of producing strong but machineable castings.

On the other hand, sulphur causes the carbon to assume the combined form, and hence gives weak, brittle metal, and should be kept as low as possible. Phosphorus renders the metal very fluid indirectly through the presence of low-melting iron-phosphide. It has no effect on the graphite-carbide ratio. Manganese up to about 1 per cent. hardens and closes the grain of the metal, and it is useful for assisting in the removal of sulphur by the formation of manganese sulphide, which passes off as a slag. Chromium increases the capacity of the iron for dissolving carbon, and hence encourages the formation of carbide, and makes the metal hard and white. Vanadium improves the physical properties to some extent, and titanium also produces a noticeable improvement in mechanical properties, especially in phosphoric irons, commonly used in the U.S.A. It is supposed to improve by uniting readily with nitrogen, and it lessens solubility of gases in molten iron. The action is probably fluxing in character.

The effects of these elements on each other and on the iron are fairly well known, but much less is known regarding their actions when two or more are present and acting simultaneously. The difficulties introduced by the simultaneous operation of so many elements are heightened by the fact that their distribution is seldom uniform, with the possible exception of phosphorus. If pigs are cast, the silicon varies from pig to pig, being lowest in the first and highest in the last. Sulphur varies in the same pig.

In ordinary grey foundry iron silicon is present up to about 3 per cent., and manganese up to 1 per cent. There are also small quantities of phosphorus and sulphur. The total amount of carbon present depends upon the conditions in the blast furnace, and the division of this into graphitic and combined carbon is determined by the conditions of cooling and by the amount of silicon. The other elements mentioned are, if present, generally added intentionally, as they are to welding rods.

It will be seen that it is practically impossible to predict the behaviour of any cast iron unless its composition and microstructure are determined. The chemical composition alone is insufficient, as previous thermal history has so much influence on the properties.

Influence of Constitution on Properties and on Welding Process.

The bearing of the above on the welding operation is apparent. A white iron, the carbon of which is combined as carbide, has to be regarded as a high carbon-steel. It is not practicable to weld a white iron of carbide content greater than that of weldable steels, unless by heat treatment the carbide can be partially graphitised. It is practicable to weld most grey irons, because the carbide content approximates to that of the weldable steels, the steel-like matrix being embrittled and weakened by the presence of graphite. The graphite, however, being included in a mechanically mixed form, does not prevent welding taking place. Successful welding appears to depend on the presence of ferrite, either free or in the pearlite form.

The welding of cast iron, however, is more difficult than the above would indicate on account of its very heterogeneous character. The properties depend so obviously on the carbon that there is danger in concluding that the percentage carbon and proportion of carbide to graphite will give all the information required.

The main part of the metal itself may be regarded as a reinforced aggregate. For low-carbon material, such as mild steel, the ferrite is

* A Paper presented to the British Acetylene and Welding Association, London.

the ductile constituent, and the pearlite the harder and more brittle material. Above 0.9 per cent. of carbon the pearlite has to be regarded by comparison as the ductile constituent and the carbide or austenite as the brittle, hard constituent. In grey irons, graphite also traverses and weakens the mass. The heterogeneity due to other elements may be indicated by the figures in Table I for a pig-iron, the iron-carbon constituents being modified by the presence of other elements.

TABLE I.—*Properties of the Constituents of Cast Iron.*

	Percentage of Whole Mass.	Density.	Melting Point °C.	Contraction inches per ft.
Silicon-ferrite ..	33—30	7.25	1,425	0.20
Iron-Manganese-Carbon Eutectic ..	53—55	7.55	1,135	0.25
Iron-Phosphorus-Carbon Eutectic ..	10—15	7.4	950	0.24
Manganese-Sulphide ..	0.2—0.3	—	1,500	.0.28—0.30

Apart from plasticity under heat due to the heterogeneous character, the shrinkage of volume during solidification is important. Carbide shrinks much more in cooling from initial to final solidification than carbon (graphite). Hence white irons shrink more than grey irons, and become much more difficult to weld. Table II shows the way shrinkage varies with the carbide-graphite ratio, and the influence of silicon in determining this should be noted.

TABLE II.—*Shrinkage of Various Types of Cast Iron.*

Iron.	Carbide.	Graphite.	Silicon.	Manganese.	Phosphorus.	Shrinkage Volume.
Open grey	0.45	3.3	2.8	1.2	0.8	0.007
Close grey	0.40	3.0	1.5	1.3	0.4	0.010
Mottled	0.95	2.3	1.0	0.4	0.7	0.013
Mottled	1.20	2.1	0.9	0.2	0.4	0.014
White	1.50	2.1	1.0	3.2	0.5	0.017
Spiegel	5.00	0.2	0.3	11.3	0.1	0.020

On solidifying initially, cast iron expands, and then shrinks in accordance with the usual law as it cools. At the point at which the solid solution changes to pearlite, theoretically 760 deg. C., but, due to the presence of other elements, about 700 deg. C., another expansion takes place, and this would normally make welding difficult, particularly in inducing strain between parts which may be respectively above and below this temperature. The differential expansion may be some distance from the actual weld, where the metal is cool, and hence failure often occurs outside the weld. This expansion at the pearlite change point, it is easy to show, is suppressed very largely in the presence of silicon, and to a lesser extent of manganese, another factor in favour of grey iron.

The difficulty regarding expansion and contraction is one of the greatest encountered in welding, and can only be satisfactorily overcome by preheating the metal to be welded. A suitable temperature is 500 deg. C. To avoid hard spots and patches which may have been set up during welding, due to sudden heating causing graphite to re-combine with iron and form carbide and then solid solution, rapid cooling preventing the change back again, it is desirable after welding to heat the whole piece up slowly to a point above the pearlite change point say, 850 deg. C., and then permit it to cool slowly, so that all carbide can be given an opportunity to form graphite. Any weldable iron should, after this normalising process, be machineable.

The heating during welding, both of base metal and rod, results in the oxidation of silicon to some extent, and to a lesser degree of manganese and carbon. Sulphur and phosphorus are practically unchanged. Welding rod should therefore contain 1 to 1.5 per cent. more silicon than the base metal, but undue excess is not desirable.

In the welding process the utmost importance should be attached to proper pre-heating, welding and normalising, and to the general conditions imposed by the metallurgical characteristics of the material. It is preferable to have skilled and properly trained operators to take care of these points rather than rely on any special properties in the rod itself. The rod should be of such character as to deposit in the weld material chemically and physically similar to the base metal. Welding losses have to be taken into account and certain additions to promote fluxing may be desirable. Some welding defects, such as blowholes and oxidation, may arise from defects in the technique of the process itself. The presence of oxides, as in burnt material, may prevent welding taking place.

An important factor in the strength of cast iron is grain size. Slow cooling helps the growth of large crystals, but the strongest irons have comparatively small grains. The cooling conditions in a weld, however, are never so slow as to permit large crystals, and generally, even under the most favourable conditions, the grain side in the weld is smaller than that of the welded part, except in very thin castings.

Welding Special Irons.

Welding "semi-steel"—that is, a toughened cast iron made by including 10 to 20 per cent. steel scrap into the cupola—should be simpler than welding cast iron, as the carbon and some impurities are diminished. It should approach ordinary mild-steel welding as the percentage of steel scrap increases. It is seldom possible successfully to cast this material from the cupola with greater proportion of steel than 15 per cent., owing largely to irregular sulphur distribution and lack of uniformity of product.

It is sometimes described as possible, and sometimes impossible, to weld malleable iron. This consists of a white iron casting in which the carbon of the carbide in the outer skin or envelope is burned out by continuous annealing at about 950 deg. C. Some of the graphite remaining is in a very fine state of division. Consequently, if the welding process involves heating up to this temperature, the graphite and iron re-combine, and the sudden cooling keeps the carbide as such, and the malleable casting becomes brittle. If it is not heated beyond a dull red and welded with a non-ferrous alloy like manganese bronze, a weld may be made without destroying the nature of the material, but doubtfully satisfactory. In malleable iron the mean total carbon is often 0.8 to 1.2 per cent. The envelope, 0.2 in. thick, may be only 0.30 per cent. carbon. In a thin malleable casting, the envelope, which may be 70 per cent. of the whole, may have a mean total carbon 0.5 per cent., and the core, the remaining 30 per cent., may have 2.0 per cent. total carbon. The core is white iron. Heating to 1,000 deg. graphitises this. The "temper carbon" in the envelope dissolves in the iron to form carbide and austenite. Thus you get practically a steel-jacketed mass of white cast iron. Whether you can weld depends entirely on the malleable iron, and in any case the nature of it is likely to be destroyed.

At the present time it would appear that important welds require a chemical and microscopical analysis of the part to be welded so that an appropriate welding rod can be made. The influence of special elements on the rod requires to be determined, and the whole question of fluxing and fluxes requires investigation, as, from the scientific point of view, practically nothing is known of this subject. Their physical and physico-chemical properties are probably more important than purely chemical properties.

Finally, the cast-iron industry is developing in the direction of special irons for particular purposes, such as high silicon irons for resisting corrosion. Research is required on the welding of such alloys.

Conclusion.

The weldability of cast iron in general and the success with which it can be undertaken in particular cases depends entirely upon its constitution, and is essentially a metallurgical problem. Considerable progress has been made in the art hitherto by methods of trial and error and private research, and much knowledge has been gained by experience. Future advance is most likely to come, and to come most rapidly, by utilising the special knowledge of the metallurgist, and by having research conducted on a representative and co-operative basis.

XUM

The Evolution of the Pig.

By H. LITTLEHALES.

One would hardly look for humour and art in an account of pig-iron, but a comic touch does enter into the subject, and there is certainly an artistic beauty in the glittering surface of a newly-broken pig. What was the earliest pig of iron like and what, as time went on, was its shape and name?

The object of this article is to attempt, in some measure, to answer these questions, and to show that the pig has a curious and interesting history.

The Earliest Pigs.

Between the lump of iron, copper, tin, etc., and the pig of iron, as we see it to-day, stretch something like 2,000 years. Far away in point of time our forefathers smelted the ore and obtained the product in the form of a lump of metal. What this lump, the forerunner of the pig, was called we do not know, but many of the lumps remain in museums and private collections. The founder of, say, 1,600 years ago naturally had his lumps of metal at hand, as the foundryman has his now ready for the furnaces. These lumps have been frequently found, with the other portions of the stock-in-trade of early founders.

For the want of a better name to apply to these lumps, they will be referred to as lumps. The lumps differed widely in shape and size, but all apparently were formed in a way to be easily portable.

An excellent drawing in Evans' bronze implements shows that these lumps were at times in the form of the present butchers' shoulder trays, the four handles being highly developed, and the body correspondingly diminished.

In Sir John Evans' work, reference is made also to another lump, round, with a hole in it. This hole Sir John considers to have been an aid to its

THE EARLIEST ENGLISH PIG IN EXISTENCE TO-DAY, POSSIBLY 2,000 YEARS OLD. *By Courtesy of the Royal Archæological Institute.*

portability, for, with a cord passed through it, the lump could have been easily carried over the back of a horse. This idea is a very probable solution of the meaning of the hole, for we know metal to have been carried on pack-horses across the narrow ways which still exist in various parts of England.

Blooms.

We are now compelled to pass over several centuries until we arrive at the time when documentary evidence is at our service. From early writings of a period considerably before the coming of the Conqueror, the name "bloom," the earliest name for the mass of metal obtained from the smelted ores, constantly occurs.

This name was maintained in use for many centuries. Not only is it mentioned in documents of the Anglo-Saxon period, but ironmasters' of the 14th century refer to blooms taken from the furnace for purchase by customers. For centuries this term was in use.

Apparently the bloom as well as the sow and pig (all really the same thing) might be of any weight that the founder or his customer considered desirable.

Of the shape of the bloom one is unable to form a clear opinion, but there is some reason to believe the bloom not to have been of the shape of the "pig" as it is known to-day. In Knight's "Pictorial Gallery of Art," published about 100 years ago, we find a reference to blooms as "balls or blooms" of iron. This seems to give some indication that the old occasionally round form of the lump was retained by the bloom.

Sows.

In the 15th century the bloom had often the alternative name of sow, both names being used for the same thing for some considerable time.

The earliest mention of sow with which we are acquainted, is in an extract in the great English Dictionary dating 1481-90, when two sows are referred to. In the Exchequer Account Rolls, in the Record Office, the purchase of early 16th century sows is set down in various bills of materials purchased.

The shape of the sow, one may reasonably believe to have been of the form of that particular animal, and hence its name.

If we look at a small sucking pig or sow as it lies flat with legs tucked under on a butcher's slab, we shall at once be struck with its likeness in form to a pig of iron, even to the rounded end of the stern.

From the years before the Conquest, the sow, or pig, was a specially familiar feature in England, and the name would easily come to be applied to a mass of metal of a similar form. This shape was probably retained, with, later on, the appellation of pig, up to the present time. If such be the case, the pigs of iron of to-day have had that same shape for the last 500 years—an interesting consideration.

Pigs.

In the early part of the 16th century, just as the name "sow" had ousted that of "bloom," the word pig seems to have ousted, in very large measure, the place of "sow" for the lump of iron from the ore.

Mother Sow and Little Pigs.—The distinction has been often drawn between sows and pigs that the casting bed consisted of a main channel, with smaller channels on either side, and that after the casting, the mass of metal of the main channel was known as the sow, and the castings in the smaller channels as pigs.

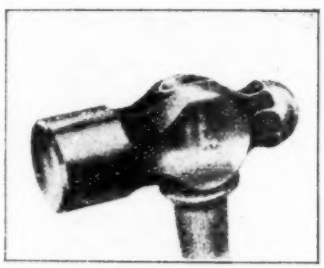
It is probable that such a form of casting was at times adopted, but one must not lose sight of the fact that contemporary documentary evidence shows that the name of sow belongs to one period and that of pig properly to another and later time.

In the 17th century pigs seem to have sometimes been subjected to a certain degree of forging, the ends not running straight off or rounded downwards but expanded or swelling out somewhat after the form of a dumb-bell into two knobs, one, the smaller, known as the "Ancony," and the larger knob known as the "Mocket Head."

Whether pigs were commonly or only occasionally turned out in this way, it is difficult to say. It is known, however, that lumps, blooms, sows and pigs all through their history, varied greatly in weight and size, but in this connection it must be borne in mind that the size of a pig of lead would, from its greater weight, need to be a good deal smaller than one of iron to be of equal portability.

Shock-absorbing Hammers.

Nail hammers and machinists ball-pein hammers having a rubber cushion inserted between the handle and the head to absorb the shock of the hammer blows have been placed on the market by the Heller Brothers Company, Newark, N.J. The arrangement of the rubber cushion may be noted



A SHOCK ABSORBING HAMMER.

from the accompanying illustration of the machinist's hammer. The rubber cushion feature, according to the "Iron Age," is said to have been tested and its success in absorbing much of the shock of the hammer blow established.

Steel Rail Practice in America.

Considerable interest appears to have been aroused in the American iron and steel industry regarding the position created by the conditions stipulated in the recent orders for 130,000 tons of steel rails for use on the Southern Pacific Railway System. The requirements were that the bulk of the rails should be in 39-ft. lengths (6 ft. in excess of the prevailing standard), and that the ends were to be milled. No rail mill in the country was in a position to comply with these conditions without modification of its plant, and in the case of the three mills to whom the order was ultimately allotted such modification has recently been completed.

In an article dealing with the subject* Mr. C. W. GENNET, JUNR., points out that the obvious reason for the increased length was the consequent reduction in the number of joints, experience having shown that a diminution in this respect up to nearly 30 per cent. can be effected without risking the effects of excessive expansion. Thus an expensive item (high in first cost as well as in maintenance) has been substantially diminished.

Milling the ends of rails is not a new departure in the States. It is a common practice with rails for export, and an invariable one in the case of girder rails for tramways. It is required to secure squareness and a positive elimination of the hot-saw burrs, and its importance has been enhanced by the use of the larger rail sections. The recent tendency when laying rails in the States has been towards leaving less opening for expansion between abutting rails, which means that the ends must be almost perfectly square, and experience has shown that hot saws do not ensure this constantly. The removal of the saw burrs by hand chipping and filing has proved unsatisfactory, very small burrs frequently preventing the joints from fitting well. A slight burr on the top of the head of the rail is often pressed into the expansion space by the first few trains that pass over it, and later, when hot weather expands the rail, a piece from the head is chipped out. Milling the rail ends apparently prevents most of these evils, while assuring less variation in lengths and more accurate drilling of bolt-holes.

Rails from Ingot Tops Often Fail.

The necessity of re-arranging the mills to provide the greater rail lengths has suggested the question whether the existing hot-bed arrangements are the best for the purpose. Rails of steel containing as much as 0.85 per cent. carbon, and well above its critical point, are often run on to the cold skids of the beds only to be quickly chilled at the places in contact with certain skids. What effect these black spots may have is doubtful, but they could easily be avoided and probably considerable rough handling of the rails eliminated if some of the unique methods employed on the hot beds of bar mills were used. The pulling up on to the hot beds of long-length rails by the present system is almost bound to affect the camber. If the present questionable practice of hand spacing and turning rails on the hot beds is followed with the longer lengths, kinks and short bends will probably be put in the rails to an even greater extent than now. Apart from these mechanical matters the old problem of obtaining sound ingots, and consequently rails that are chemically and physically fit, is still a pressing one. Apparently the heavier sections have served only to delay appearance of the defects for which segregation and unsound steel are considered responsible. Again and again it can be shown that half of all the troubles with rails in service occur in the top rails of the ingots. Yet these top rails constitute only from 10 to 15 per cent. of the product, depending, of course, on the size of the ingots used.

In the case of large 6-ton ingots it is highly probable that the second rail is frequently as bad as the top rail from the smaller 3½-ton ingot. Certainly the development of the steelworks practice in the direction of using larger units, while economically desirable from a mill standpoint, has had an adverse effect on the quality of rails rolled from near the top of the ingots.

Certain railways are obtaining relief from the pernicious influence of top rails by some method usually made possible by a particular mill condition. Thus, this year 100,000 tons of rails are to be rolled at one mill with the nick-and-break test made on the top rail of each ingot. The Santa Fe Railway System has taken the lead in prescribing a 25-per-cent. top discard on a part of its rails. This, however, has the disadvantage of increasing the cost, and, for that reason, will perhaps not become a common practice.

The chemical composition of modern rail steel, concludes Mr. Gennet, is frequently a subject of discussion, and arguments are advanced favouring the use of a higher phosphorus content to offset the present high-carbon, and, perhaps, the use of more manganese. Trials of some such steels are being suggested, the idea, of course, being to produce a steel in the open-hearth furnace of more nearly the chemical characteristics, and hopefully some of the physical ones, of the old-time Bessemer rails, which gave long life and were apparently free from some of the defects so often associated with high-carbon steels.

In this connection, also, may be asked the question: What is the best method of making the common rail steel of to-day in the basic open-hearth furnace? Is duplex steel as good as that of the straight open-hearth? Is that made by the continuous process positively reliable? What is the best method for recarburising? Is it desirable for a certain amount of manganese always to be present in the bath to ensure the best results? These are some of the pertinent matters deserving study, for neither heavier-section rails nor longer rails will overcome the evils incident to the use of bad steel.

* "The Iron Age."

Symposium on Diesel Engine Castings.

Conversations on matters relating to Diesel engine castings have been taking place between representatives of the Glasgow and West of Scotland Branch of the Institution of Mechanical Engineers and of the Scottish Branch of the Institute of British Foundrymen, and at a meeting held in the Royal Technical College on June 18 it was decided to hold a symposium on the subject. It is the intention to hold this meeting at the Royal Technical College, Glasgow, on Thursday, October 16, when short papers will be read on the following aspects of this important subject:—

1. "Temperature, Stress and Working Conditions of Oil Engines," by Professor A. L. Mellanby, D.Sc.
2. "Characteristics of Cast Iron for Oil Engines," by Professor A. Campion, F.I.C.
3. "Oil Engine Design as Affected by Foundry Practice," by Mr. James Richardson, B.Sc., M.Inst.C.E.
4. "Oil Engine Design from a Moulder's Point of View," by Mr. Wm. Bell.

The symposium is regarded as being little more than an introduction to the subject, and it is hoped that it may lead to fuller and more important discussions between the two bodies at a later date.

The Institution of Mechanical Engineers was represented by Professor A. L. Mellanby, D.Sc., Mr. James Richardson, B.Sc., M.Inst.C.E., and Mr. A. Strathern, and the Institute of British Foundrymen by Professor A. Campion, F.I.C., Mr. A. Lawrie and Mr. John Bell.

A.F.A. Prize for Ideas.

An institution well worth copying by other nations is that which has been originated by the American Foundrymen's Association. Each year there is an award called the Obermeyer Prize, which is given to a person submitting a device, drawing or model of some jig or method which, in the opinion of the judges, embodies the best ideas for the economical production of castings. It must be such that it can be constructed in any foundry and used in the production of castings, in core making, moulding or handling operations. We feel sure that Mr. C. E. Hoyt, the secretary of the American Foundrymen's Association, whose address is 140, South Dearborn Street, Chicago, Illinois, U.S.A., will send the conditions governing this award to anybody interested.

XUM

The Rapid Production of Malleable Iron.*

In a Paper read before the Detroit meeting of this Society in October, 1922, the results of experiments whose purpose was to shorten the annealing time for the malleabilisation of white cast iron were given. The object of the present Paper is to report the results of further experimental work, whose purpose was to shorten further the annealing cycle for complete graphitisation of white iron. Also, it was desired more carefully to study the conditions for the production of intermediate products, to develop new intermediate products and to investigate further their physical properties. Previous work showed that it required about three hours at 925 to 948 deg. C. completely to absorb massive cementite. This work also showed that the absorption of this cementite was much slower at the lower temperature used in the commercial process. It is essential that all massive cementite be absorbed before cooling starts and that the cooling be so regulated that no grain boundary cementite be precipitated as the temperature falls to that of the lower critical.

Having eliminated all free cementite for all temperatures above the critical, a further condition for obtaining complete graphitisation is that the rate of cooling through the critical (the iron-carbon eutectoid) be retarded sufficiently to avoid the formation of pearlite. It is well known that this final cooling rate is 5 to 6 deg. C. per hr. as a maximum. With these facts in mind the following treatment was used for shortening the cycle for complete graphitisation. Ten standard ½-in. tensile test bars were placed on end, unsupported and unpacked, in a hump furnace whose temperature was 925 deg. C. The temperature was dropped to 645 deg. C., and it required 40 min. for it again to reach 925 deg. C.

This temperature was maintained for three hours and it was then lowered to 845 deg. C. for one hour. Then the cooling rate was reduced so that the bars cooled uniformly and slowly to 715 deg. C., which required 14 hr., or at the rate of 10 deg. per hr. At this time the rate was further reduced to 5 deg. F. per hr., so that the bars cooled to 645 deg. C. in an additional time of 12 hr. The process was considered complete when 645 deg. C. was reached, and it will be noted that the complete overall time required was within 31 hr. It has been shown that the iron-carbon eutectoid for white cast iron lies at 770 deg. C., and that it is easily undercooled to about 715 deg. C. Therefore, in the above experiment the 5-deg. cooling rate was not used until a temperature of 715 deg. C. had been reached. Three of these bars were tested and gave the following results:—

Tensile Strength, Tons per Sq. in		Yield Point, Tons per Sq. in.		Elongation. Per cent. in 2 in.
21.4	...	13.4	...	14
20.3	...	13.5	...	11
21.5	...	13.7	...	12

It is believed that an application of these principles will allow a more rapid cooling rate between 845 deg. C.; also, it is almost certain that material can be removed from the furnace at temperatures higher than 715 deg. C. without hurting the resulting properties. A one-day malleable is well within the possibilities of laboratory demonstration.

It is considered desirable at this point to state rather carefully the principles which underlie the control of properties when graphitisation is only partially completed. It is known that the effective strength of grain boundary cementite in hypereutectoid steels is very low, probably approximately 22 tons per sq. in. Grain boundary cementite, when present, also tends sharply and radically to reduce the ductility. As long as the massive cementite is present in a white iron at annealing temperatures there is always grave danger that grain boundary or "shell" cementite will form during the subsequent cooling. It is imperative, therefore, that the high temperature be maintained until all massive cementite be absorbed and further, the cooling down to the critical must be so regulated as to avoid the formation of "shell" cementite. This is necessary if materials having tensile properties of any commercial promise are to be obtained.

It is evident from the foregoing that combined carbon in excess of that to form pearlite will result in undesirable physical properties. It is known that in steels of normal structure the strength increases with carbon increase until a structure of 100 per cent. pearlite is attained, at which time it has reached a value of 55 tons per sq. in. and, though the ductility decreases with carbon increase, a pearlitic steel retains 10 per cent. elongation. It would be expected, therefore, that a material of maximum possible strength would be obtained from white cast iron if the graphitisation proceeded only until a pearlitic matrix resulted, and moderate elongations should still be retained. This material would then consist of pearlite containing about 10 per cent. by volume of temper carbon and the resulting properties should approach

TABLE I.—*Some Comparative Results.*

Treatment.	Overall Time Hr.	M.S. Tons per Sq. in.	Apparent Y.P. Tons per Sq. in.	E. Per Cent. in 2 in.	Impact Values (Izod) Ft.-Lb.
3 hr. at 925 deg. C.; cool to 845 deg. C. in 45 min.		33.2	21.9	4	8
3 hr. at 845 deg. C.; cool to 645 deg. C.; cooling rate of 3.5 deg. C. per min.	8	30.2 30.1	21.9 19.4	3½ 5½	8 8
3 hr. at 948 deg. C.; cool to 895 deg. C. in 45 min.		30.8	22.1	4½	8
3 hr. at 895 deg. C.; cool to 645 deg. C.; cooling rate of 2.5 deg. C. per min.	9	29.9 32.4	19.8 21.2	4½ 5½	10 8
3 hr. at 948 deg. C.; cool to 845 deg. C. in 1 hr. 20 min.		30.9	20.0	6	8
6½ hr. at 845 deg. C.; cool to 645 deg. C.; cooling rate of 2 deg. C. per min.	13	30.7 26.9	20.3 20.3	5½ 6	8 8
3 hr. at 948 deg. C.; cool to 895 deg. C. in 1 hr.		23.9	16.3	9	8
3 hr. at 895 deg. C.; cool to 645 deg. C.; cooling rate of 1.5 deg. C. per min.	10½	25.3 25.7	16.1 17.0	8½ 10	8 8
For Comparison.					
3 hr. at 925 deg. C.; cool to 845 deg. C. in 1 hr.		21.4	13.5	14	
Cool to 715 deg. C.; rate 10 deg. 1 hr.	31	20.1 21.5	13.6 14.2	11 12	
Cool to 645 deg. C.; rate 5 deg. 1 hr.					
Impact test on Malleable from same pour					14
Annealed with commercial run of work ..					15

Remarks: Impact tests were run on bars from the same heat but not on the same bars as used for tensile tests. Tensile tests run on bars as cast.

those of pure pearlite. If the graphitisation is carried beyond this point, the strength should progressively decrease and the ductility should progressively increase until they attain values as found in normal malleable cast iron.

Table I gives results achieved in five different treatments of white cast iron varying in overall time from 8 to 13 hr. At 10½ hr. a material was produced which in tensile strength, yield point, elongation and izod value met the specifications of the American Malleable Castings Association.

There is a general rule known to hold for all normal iron-carbon alloys that the yield point has a value of about two-thirds of the tensile strength. Any of the products here presented conform very closely to this rule. The yield points obtained are of the same order of magnitude as those found in

* "Iron Age." Abstract of a Paper, "Possibilities of Producing Malleable Iron and Intermediate Products of Value in Short Annealing Periods," presented by Dr. Anson Hayes and W. J. Diederichs, Iowa State College, Ames, Iowa, at the Sixth Sectional Meeting of American Society for Steel Treating.

normal steels of the same combined carbon content. The izod impact test on these intermediate products of annealing gave results which remained practically constant at 8 ft.-lb., regardless of the treatment. It is obvious that this value is sharply doubled when complete graphitisation has been accomplished. It is of interest to note, however, that this impact value compares very favourably with values for normalised cast steel.

There has been occasion for machining these intermediate products both on a lathe and on a milling machine, and they presented no difficulty. The surface produced resembles that of machined steel very closely. It would seem that a cast iron, which by a short treatment can be given properties such as reported, should find commercial uses as a substitute for malleable iron and steels for certain purposes. The yield point is as high as that for normal steels of the same combined carbon content and is superior to that of malleable iron. The shock resistance is comparable to that of steel and though less than that of malleable iron would seem to be ample for many purposes. The ductility also would seem to be ample to allow the slight changes in shape sometimes required in assembling and similar operations.

It is realised fully that the treatments here given differ from those used commercially. Somewhat higher temperatures are used, more rapid temperature changes are involved and the use of any packing material is eliminated. These changes are considered necessary in order to realise the short annealing period obtained in those experiments. It is believed that the employment of a suitable atmosphere with a travelling hearth furnace offers possibilities of making those laboratory treatments commercially feasible.

A Self-Contained Magnet Scrap-Handling Crane.

Some features of special interest attach to the design of the crane illustrated herewith, which shows an application of the "Phœnix" patent electro-lifting magnet equipment to an existing steam crane, for which installation Messrs. E. G. Appleby & Company, 70, Victoria Street, Westminster, London, were responsible.

FIG. 1.—PHŒNIX MAGNET CRANE HANDLING LOAD OF SCRAP.

The crane is a 7-ton loco. steam crane, and the magnet a "Phœnix" of the circular type, 48 in. in dia. A spring cable-coiling drum is fitted to the jib of the crane to coil the flexible cable conveying current to the magnet so that the cable is kept taut as the magnet rises and falls, thus eliminating the possibility of the cable fouling the crane chain or the magnet with its load. Current for the magnet is supplied from a turbo-dynamo housed in the driver's cabin. The turbine has many advantages as regards convenience, absence of vibration and general handiness; further, it occupies less space, and the weight is much less than that of reciprocating-engine sets. The turbo-dynamo is supplied with steam from the crane boiler, and develops 7 b.h.p. (4.4 kw.). The switch panel for the dynamo consists of an angle-iron frame carrying a D.P. switch and fuse (ironclad type), one ammeter and one voltmeter, both with terminals totally enclosed, and a shunt regulator.

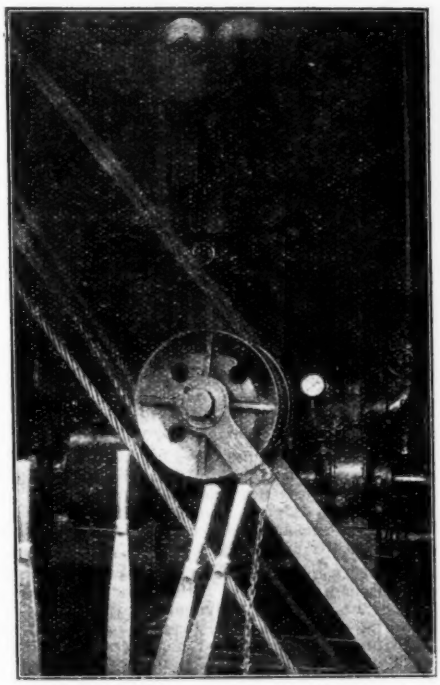


FIG. 2.—VIEW IN CABIN SHOWING TURBO-GENERATOR SET WHICH SUPPLIES POWER FOR "PHŒNIX" MAGNET.

The control gear for operating the magnet is the "Phœnix" patent contactor gear, which, specially designed for magnet service, claims the following advantages:—(1) No permanent resistance in series with the magnet coil; (2) no discharge resistances; (3) foolproof operation; (4) no catches or mechanical time lags; (5) all switchgear ironclad. The master controller is separate from the contactor panel, and is placed handy to the crane driver so that he has effective control of the whole operation of the crane and magnet.

It will be obvious that an arrangement of this nature considerably enhances the value of a crane for handling scrap and similar material, and as the arrangement is independent of any outside source of power supply it can be brought into service in out-of-the-way positions.

Trade Talk.

A LICENCE under the Non-Ferrous Metal Industry Act, 1918, has been granted to S. H. Colton, 110, Cannon Street, London, E.C.4.

FOUNDRY PLANT AND MACHINERY, LIMITED, 28, Royal Exchange Square, Glasgow, have removed their registered office to 100, Wellington Street, Glasgow.

THE HOFFMANN MANUFACTURING COMPANY, LIMITED, of Chelmsford, have removed their Glasgow office from 62, Robertson Street, to 192, West George Street, Glasgow, C.2.

STANLEY BELL (WAGONS), LIMITED, have removed their head offices from York Chambers, Wallgate, Wigan, to their works at Walmsley Sidings, Reddish, near Stockport.

CONSIDERABLE DAMAGE was done by a fire which occurred at the marine engine works of George Clark, Limited, Southwick-on-Wear, recently, when a large pattern shop was burnt out.

GREENWOOD & BATLEY, LIMITED, have acquired the whole of the outstanding debentures of the Albion Turbine Company, Limited. For many years Messrs. Greenwood & Batley have held all the shares of the Turbine Company, and conducted the business as a department of Greenwood & Batley, Limited.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, have secured the contract for the construction of a dam, spillway, headworks and power house, and the installation of plant in connection with the New Zealand Government's Arapuni hydro-electric scheme. The cost of the undertaking will be £1,175,652.

AN EXCELLENT EXAMPLE of the speed at which iron ore is discharged at Port Talbot docks is furnished by the case of the s.s. "Glynymel," which commenced discharging a cargo of 2,518 tons of iron ore at 7 p.m. on a Friday, and finished at 6 p.m. on the following Tuesday week. The actual number of crane hours worked during the discharging operations were 88¾.

THE AUSTRALIAN TARIFF BOARD'S annual report mentions, with reference to the question of tariff revision, that the position of the iron and steel and engineering industry threatens to become acute, notwithstanding liberal tariff protection, owing to the pressure of competition from countries with lower wages and depreciated currency. There was the keenest competition from Great Britain owing to the granting of preference on goods containing only a 25 per cent. proportion of British labour and materials.

VICKERS, LIMITED, hydro electric department, have received an order for two large water turbines from the Government of Ontario through its Hydro-Electric Power Commission. Each turbine will have an output of more than 12,000 h.p., the height of fall being 72 ft. The power will be used for industrial purposes in and about Fort William and Port Arthur on the north shore of Lake Superior. These turbines will be built at Barrow-in-Furness, where Messrs. Vickers already have a substantial volume of such equipment under construction for various parts of the Empire.

BOSTOCK & BRAMLEY inform us that the rapid expansion of their business of power transmission engineering, especially in connection with enveloping worm gear and concentric speed transformers, together with the development of American interests, have necessitated certain changes in their organisation. Capt Bramley-Moore is leaving this country to reside in the United States and, in order to effect a closer working with Joshua Buckton & Company, Limited, with whom they are in association, the business is being transferred from Netherton to Leeds, the new address being Dewsbury Road, Leeds.

MELDRUMS, LIMITED, Timperley, near Manchester, have recently received orders for 38 sets of forced draught furnaces and/or mechanical stokers from tar distillers (repeats), chemical manufacturers, engineers (stokers), collieries, steel works, etc. There has been a good demand for plants for the disposal of refuse, and the company have received orders during the same period for 20 of these plants, mainly for the disposal of dangerous refuse, some being for the utilisation of heat in boilers or water heaters. Other orders recently taken include five portable steam disinfectors, a motor road sweeper-loader, several motor-car trailers, etc.

IN CONSEQUENCE of the death of Mr. A. W. Sainsbury, managing director of A. W. Sainsbury Limited, it has been found necessary to wind up the affairs of that company. Members of the old concern have formed themselves into a new company under the style of Wilkinson, Bentley & Company, Limited, to carry on similar business as general engineers. The directors of the new company are Capt. J. Wilkinson and Mr. F. A. Bentley, both of whom, together with the staff and employés, who are being retained, have served many years with the old Company. The offices are at Sainsbury's Buildings, Campo Lane, Sheffield.

Company News.

Steel Company of Canada.—Quarterly dividend, 1¾ per cent.

Mather & Platt, Limited.—Interim ordinary dividend, 5 per cent. actual, tax free.

Beveridge & Skinner, Limited, Kirkcaldy.—Capital £5,000 in £1 shares. Engineers and ironfounders.

Bayliss & Wilson, Limited, High Street, Wednesfield.—Capital £1,500 in £1 shares. Stampers, piercers, steel metal workers, etc.

Dobbertin & Company (London), Limited, 133, Moorgate, London, E.C.—Capital £5,000 in £10 shares. Iron merchants.

Monks, Hall & Company, Limited.—Profit, £34,807; balance, £90,078; final dividend, 2½ per cent., making 5 per cent., tax free; forward, £77,621.

Baker Brothers, Limited.—Capital £1,500. Electrical and mechanical engineers, etc. Permanent directors: R. M. Baker (managing) and W. P. Baker (secretary).

Brent Foundry Company, Limited, 4, South Wharf, Paddington, London, W.2.—Capital £10,000 in £1 shares. Directors: A. G. Harris, J. P., P. M. Harris, J. P., and S. S. Rogers.

Electrical Wholesale Supplies (Leicester), Limited, 58, Halford Street, Leicester.—Capital £3,000. Directors: J. T. Kemp, T. N. G. Gelsthorpe and G. H. Gelsthorpe.

H. H. Jackson & Company, Limited, 17, Duncan Terrace, London, N.—Capital £1,000. Engineers, etc. Permanent directors: H. G. Casperson, H. E. Holden and H. Law.

Scammell Winches, Limited, Romford, East Knoyle, Salisbury.—Capital £11. Directors: A. G. Scammell and P. G. Hugh.

Westwood & Wrights, Limited, Round Oak, Brierley Hill.—Capital £40,000 in £1 shares. Mechanical, electrical, hydraulic and constructional engineers.

Wilkinson, Bentley & Company, Limited, Sainsbury's Buildings, Campo Lane, Sheffield.—Capital £3,000 in £1 shares. Engineers. Directors: J. Wilkinson and F. A. Bentley.

Wm. Riddell, Cousland & Company, Limited, 636, Springfield Road, Bridgeton, Glasgow.—Capital £60,000 in 10,000 7½ per cent. cumulative preference shares and 50,000 ordinary shares of £1. Wire workers and wire cloth manufacturers.

Greenwood & Batley, Limited.—Balance, £30,237; brought in, £15,480; available, £45,717; depreciation, £6,000; final dividend on ordinary, 2½ per cent., making 5 per cent. for year; carried forward, £15,270.

Petters, Limited.—Balance, after providing for depreciation, bad and doubtful debts, was £36,134; preference dividend, 7½ per cent. per annum for half-year ended March 31, 1921, less tax; carried forward, £30,884.

Obituary.

MR. CHARLES HENRY WESTLEY, of Bewdley, died last week, aged 93. Until thirty years ago he was in business at Dudley as a brassfounder.

MR. JOSEPH WOOD, formerly head of J. Wood & Sons (Wisewood), Limited, Wisewood Forge & Rolling Mills, Sheffield, died recently in his 83rd year.

MR. RICHARD NICHOLSON, managing director of John Nicholson & Son (Sheffield), Limited, Mowbray Steel Works, Sheffield, died recently in his 71st year.

MR. DAVID CORBETT, who died on July 11, had been prominently associated with commercial affairs in Middlesbrough for many years. The deceased gentleman, who was 59 years of age, was a native of Tyneside, and went to Middlesbrough in 1888, entering the service of Swan Bros., iron merchants, ultimately becoming a partner in the firm. Business circles on Tees-side heard with great regret of the death of Mr. Corbett, which occurred after a serious operation. He was well known and highly respected on 'Change.

MR. ALBERT G. KEEN died recently, after a short illness, at his residence, "Oakfield," Woodbourne Road, Edgbaston. The deceased gentleman was the third son of the late Mr. Arthur Keen, Edgbaston, the well-known ironmaster. Mr. Keen was only 49 years of age. He was educated at Uppingham School, and upon leaving he became articled to Pember and Boyle, stock and share brokers, of London. At the conclusion of his period of service he became a partner in the firm of J. & J. M. Smith (Birmingham), which at a later date took the style of Smith, Keen, Barnett & Company. Mr. Keen was also a director of the New Cransley Iron & Steel Company, Limited, of Kettering.

COLTNESS IRON CO., LTD.

Makers of the well-known and old-established

"COLTNESS" BRAND OF HIGH CLASS SCOTCH PIG IRON

FOUNDRY. No. 1, No. 3, No. 4.	**STANDARD GRADES**	HEMATITE. No. 1, No. 3, No. 4.

Works:— Newmains, Lanarkshire.

PRICES, ANALYSES, ETC., MAY BE OBTAINED ON APPLICATION TO THE GLASGOW OFFICE.

Office: 138, West George St., Glasgow.

For "OIL CORES"

to give

EXCELLENT SKIN ON CASTINGS

use

"THE" Sand which is "RYARSH"

(98% Silica)

Full particulars from

RYARSH SAND CO., LTD., The Quarries, Ryarsh, Malling, KENT.

'Phone: 63 WEST MALLING.

GIBBONS BROS., LTD.,

Telephone: Dudley 2450 (2 lines).

DIBDALE WORKS,

DUDLEY.

Telegrams: "Gibbons, Lower Gornal."

PATENTEES AND BUILDERS OF

INDUSTRIAL FURNACES

COAL, COKE, OIL OR GAS FUEL.

Designs and Estimates Submitted.

Representatives for

W. S. ROCKWELL FURNACE CO., NEW YORK.

HEAD OFFICES—DUDLEY.

Branch Offices—LONDON, MANCHESTER, MELBOURNE, BRISTOL.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The slight improvement noted in the Cleveland iron trade in last week's report has, unfortunately, been of brief duration, market conditions having relapsed into quiet conditions, almost approaching stagnation, both in home and export business. In each of these sections of the market a somewhat pessimistic view is taken of the position, the prolonged slackness in the demand for foundry products especially affecting the consumption of that quality pig, while the state of the Continental exchange precludes any expansion of shipments in that direction. Prospects of a favourable change are, however, not wanting, but the prophecies are, unfortunately, very slow of fulfilment. It may be that when the autumn opens the present lassitude will give place to activity, but meantime the problem is to get through the prolonged trials of comparative stagnation. It is not, therefore, surprising that prices have developed a further weakening tendency in this week's market, No. 3 G.M.B. having been quoted at 87s. f.o.t. and 87s. 6d. f.o.b., but both figures could be shaded against firm offers. No. 1 was 92s. to 93s., No. 4 foundry 86s., and No. 4 forge 85s. per ton.

The weakness in the hematite trade is maintained. Home demand shows no improvement, while abroad the competition of French hematite is limiting inquiry to buyers who require the superior British product or to special brands. At this week's market East Coast mixed numbers were freely offered at 94s 6d. per ton, and even a lower figure could be negotiated for a fair parcel. No. 1 was 6d. per ton more. On the North-West Coast condition and values remain unchanged, with current quotations for Bessemer mixed numbers held at 105s. 6d. per ton delivered Glasgow, 110s. delivered Sheffield, and 115s. per ton delivered Birmingham.

LANCASHIRE.—In this area the market for foundry pig continues practically lifeless, ironfounders having very few orders in hand, and that is one reason why so many of them are unwilling to buy more pig-iron. There is now some idea that iron is accumulating rather uncomfortably at the Midland furnaces, and that greater efforts to sell it will be necessary. Most Derbyshire makers still quote 98s. per ton for No. 3 delivered in Manchester, but probably business could be done at 97s. 6d. per ton, while it is evident that some makers are anxious to get more orders.

THE MIDLANDS.—Very little buying of foundry iron was reported at the quarterly meeting, and prices still indicate a downward tendency, consumers as a rule preferring a waiting policy in view of a probable further reduction of values in the near future. Current quotations rule as follow:—Derbyshire No. 3 foundry, 90s.; Staffordshire No. 3 foundry, 90s.; Northants No. 3 foundry, 95s.

SCOTLAND.—With the commencement of the annual holiday season buying of any description of iron in the Scottish markets has practically ceased for the time being. Quotations continue weak, No. 3 foundry being obtainable at 93s. 6d. per ton f.o.t. furnaces. There are still no signs that the low level of values is bringing out more business.

Finished Iron.

There is still nothing encouraging to say about finished iron. Very little trade is being done outside marked bars, and the demand for these is not quite so vigorous as it was. It is a very significant indication of conditions that the increase of 10s. in Yorkshire crown bars which was recently announced has not provoked a similar movement in other districts, Midland manufacturers recognising that conditions will not permit them to make such a movement. The price is already so high that it seems to have checked demand and transferred a lot of it to steel. The comparatively little iron that is being made is mostly against specifications for special purposes for which iron is regarded as more suitable than steel. Makers of the commoner grades are even worse off, because the brunt of the very severe competition is on them. There is no quickening in connection with gas strip, nor does there seem likely to be when steel strip of very good quality is obtainable at much less.

Steel.

Conditions in the steel industry continue quiet and uneventful, billet makers reporting that buying has fallen away almost to nothing, though acid qualities are less stagnant than basic. Open-hearth steel production has collapsed badly, but crucible steel is picking up somewhat, both on home and export account. Tool steel is a good feature, and the lighter branches of the steel trade are in a more satisfactory position than the heavy sections. In the market for alloys it will be satisfactory to consumers to hear that the price for ferro-manganese has been reduced by £1, making the present quotation £16 per ton delivered. In the tinplate market specifications have been coming in better, and consumers in the home trade have also been buying for September onwards. Some works are still asking up to 23s., but practically all of the business actually booked has been at the official minimum of 22s. 7½d. f.o.b.

Scrap.

Business in all qualities of scrap metal continues in an unsatisfactory condition, consumption on every hand being restricted in volume owing to the prevailing slackness in the foundry industry. The demand for cast-iron scrap in the Manchester district is consequently very inadequate, and it is to be feared that stocks in dealers' hands are increasing. This leads to sharp competition to secure the few orders offering, and although some of the stronger dealers here are still quoting 90s. for the best lots of broken machinery metal, considerably less than this price has been heard of. In Scotland machinery cast-iron scrap, in pieces not exceeding 1 cwt. suitable for foundries, is 95s. per ton, and for ordinary quality to the same specification 90s. to 91s. 3d. per ton. Foundries, however, are not in the market at present, with the result that the sales are practically of no account meantime. Light cast-iron scrap is now easier at 75s. per ton, and for this class of material mixed with firebars 2s. 6d. per ton less. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Recent developments in the standard copper market suggest a somewhat steadier tendency on the whole, while fluctuations in values have been within extremely narrow limits. Too much credit is not given to the recent reports of the remoteness of the earning capacity of American trade, and it is argued that conditions in the United States have reached the worst. The Continent remains entirely out of the market. Reports from the industrial areas indicate a quietly steady trade on the part of consumers, but very little, if any, buying for stocking or forward delivery. Current quotations: — *Cash*: Thursday, £60 12s. 6d.; Friday, £61 2s. 6d.; Monday, £62 5s.; Tuesday, £62 7s. 6d.; Wednesday, £62 10s. *Three Months*: Thursday, £61 12s. 6d.; Friday, £62; Monday, £63 2s. 6d.; Tuesday, £63 7s. 6d.; Wednesday, £63 10s.

Tin.—Early in the past week the market for standard tin underwent a distinct improvement, values marking a steady improvement from day to day with considerable buying in evidence, largely it must be supposed, on speculative account. Evidently the bulls are relying upon the reports of a boom in American trade in the fall of the year, while there is also great confidence in a revival of the world's trade, and the market reflects these views in the frequent and heavy fluctuations as either one or the other opinion predominates. There is certainly not any considerable demand from the Continent, while the apathetic state of the American demand has considerable bearing on the position for the time being. Current quotations:—*Cash*: Thursday, £229 10s.; Friday, £231 12s. 6d.; Monday, £241 5s.; Tuesday, £245 10s.; Wednesday, £242. *Three Months*: Thursday, £230 15s.; Friday, £233; Monday, £242; Tuesday, £245 10s.; Wednesday, £242 5s.

Spelter.—Conditions in this section of the market continue quiet, although consumption with the greater activity in the galvanising industry is expanding. The manufacturers, however, having covered immediate needs, are more inclined to wait on the expectation of heavy American offerings. Current quotations:—*Ordinary*: Thursday, £31 17s. 6d.; Friday, £31 18s. 9d.; Monday, £32 2s. 6d.; Tuesday, £32 5s.; Wednesday, £32 11s. 3d.

Lead.—The position in the market for soft foreign pig continues unsettled, the building dispute having had the effect of checking consumption, and adding to the uncertain feeling that prevails. This is intensified by the threat of further trouble on the railways. The question of the future situation in Germany, and other countries abroad, and the disturbed exchanges, together with the threat of an increase in the bank rate, have contributed to limit trade. Consumers are uncertain also as to the speculative position in view of the conflicting reports. Current quotations:—*Soft foreign (prompt)*: Thursday, £32 17s. 6d.; Friday, £32 16s. 3d.; Monday, £32 10s.; Tuesday, £32 17s. 6d.; Wednesday, £33 2s. 6d.